Physical Oceanography, Dissolved Nutrients, Phytoplankton Production, Plankton Biomass and Sedimentation in St. Georges Bay, N.S., 1977

by
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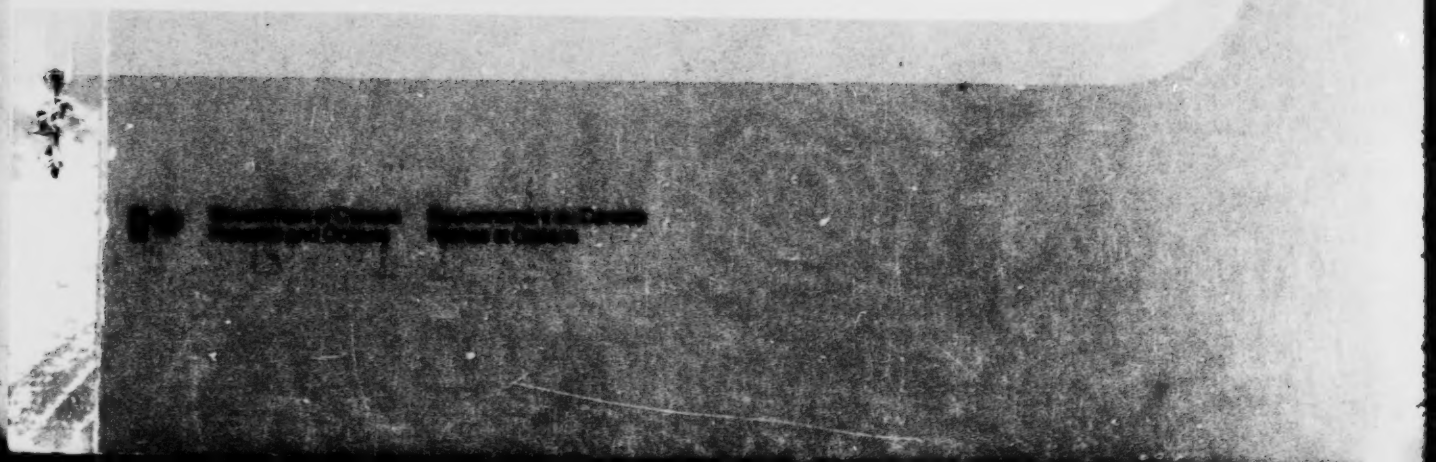

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PHYSICAL OCEANOGRAPHY, DISSOLVED NUTRIENTS, PHYTOPLANKTON PRODUCTION, PLANKTON BIOMASS AND SEDIMENTATION IN ST. GEORGES BAY, N.S., 1977

by

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ABSTRACT

Marine Ecology Laboratory. 1980. Physical oceanography, dissolved nutrients, phytoplankton production, plankton biomass and sedimentation in St. Georges Bay, N.S., 1977. Can. Tech. Rep. Fish. Aquat. Sci. 9342, 162 p.

Water temperature, salinity dissolved nutrients, suspended particulate carbon, nitrogen and plant pigments, phytoplankton production and organic matter deposited in sedimentation traps and present in sediments were measured at inshore and offshore stations in St. Georges Bay, Nova Scotia, between May and November 1977. Plankton biomass, size composition and lipid content were measured at a station near the centre of the bay. The measurements are discussed in terms of seasonal changes in the production and supply of particulate organic matter to pelagic benthic populations in this coastal bay.

RESUME

Marine Ecology Laboratory. 1980. Physical oceanography, dissolved nutrients, phytoplankton production, plankton biomass and sedimentation in St. Georges Bay, N.S., 1977. Can. Tech. Rep. Fish. Aquat. Sci. 9342, 162 p.

Entre mai et novembre 1977, on a mesuré, dans des stations côtières et des stations situées au large dans la baie St. Georges (Nouvelle-Ecosse), la température de l'eau, la salinité, éléments nutritifs dissous, le carbone particulaire en suspension, l'azote et les pigments de plante, la production de phytoplancton et les matières organiques déposées dans des pièges de sédimentation et présentes dans des sédiments. On a mesuré la biomasse planctonique, la composition par taille et la teneur en lipides dans une station se trouvant à proximeté du centre de la baie. On discute des mesures obtenues en fonction des changements saisonniers qui se produisent dans la production de matières organiques particulaires et dans l'absorption de ces matières par les populations pélagiques et benthiques de cette baie côtière.

INTRODUCTION

This report summarizes data collected during 1977 in St. Georges Bay, Nova Scotia. The Bay is a shallow coastal embayment approximately 30 x 30 km with a mean depth of about 30 m. It is open at its northern end to the Northumberland Strait and the Gulf of St. Lawrence (Fig. 1). Since 1973 St. Georges Bay has been the site of several field investigations by the Marine Ecology Laboratory due in large part to its relatively high fish production. Mackerel and hake spawn in the Bay while mackerel, hake, and lobster larvae are found in relatively high numbers. The nearshore regions (<3 km) are thought to be nurseries for juvenile fish (Ware, personal communication). The Bay contains commercial stocks of lobster, hake, and scallops as well as migrating stocks of herring and mackerel. The fisheries that these stocks sustain are economically important to many local communities.

Early studies through to 1975 were principally concerned with the abundance and distribution of fish eggs, larvae, and zooplankton (Ware 1977), the physical oceanography (Petrie and Drinkwater 1978a,b), and their possible inter-relationships. These studies were also used to assess possible biological and physical oceanographic effects on the Chedabucto-St. Georges Bay ecosystem resulting from construction of the Canso Causeway across the Strait of Canso in the mid-1950s (Harding et al. 1979; Drinkwater 1979). In 1976 work began on the lower trophic levels and sedimentary processes in the Bay (Prouse and Hargrave 1977).

The data presented in this report were collected for two purposes: firstly, to describe the seasonal patterns and to determine whether any broad scale relations exist within the Bay between temperature, salinity, dissolved inorganic nutrient concentrations, chlorophyll concentrations, primary production, sedimentation of inorganic and organic material, and zooplankton biomass, lipid content, and size composition; secondly, observations were made to determine if a nearshore zone of increased biological production exists during periods of summer stratification. A description of the sampling and analytical methods precedes the presentation of results and discussion of each separate investigation. A general discussion which synthesizes the results follows.

SAMPLING AND ANALYTICAL METHODS

Physical Oceanography

Temperature and salinity samples were collected on a weekly to biweekly basis along a transect 3 km south of Ballantynes Cove (Fig. 1) using Nansen bottles with reversing thermometers. Salinities were later analyzed using an Auto-lab salinometer. Temperature and salinity were also measured along transects running both the length and breadth of the Bay and off Livingstone Cove in Northumberland Strait using either an Industrial Instruments Model RS5-3 or a profiling Aanderaa current meter with temperature and salinity sensors. Currents were investigated using over-the-ship profiling Aanderaa or Bendix current meters and a total of five Aanderaa current meters were moored at stations 7 and 12 of the Ballantynes Cove transect together with sediment traps during a 28-day period in July-August. Other data collected during 1977 included the release of 396 drift bottles along the Ballantynes Cove transect and 50 drift bottles along a transect off Livingstone Cove. Wind rate and direction at 8 m height together with air temperature and pressure were recorded at Ogden Pond.

Plant Pigments

Sea water (500 mL) was filtered through 0.45 µm Millipore filter, the filter was folded and placed into a vial with 15 mL 85% acetone containing a few drops of $MgCO_3$ solution. Samples were mixed on a Vortex mixer and stored at 5°C for 18 hr before chlorophyll *a* and pheopigments in suspended and sedimented material were measured on a Turner fluorometer following the method of Yentsch and Menzel (1963) as modified by Holm Hansen et al. (1965) and outlined by Prouse and Hargrave (1977).

Organic Carbon and Nitrogen

Samples for measures of suspended particulate carbon and nitrogen were collected by filtering 0.5 to 1 L sea water through prebaked 0.8 µm silver filters (Selas Flotronics) and stored in disposable plastic Petri dishes until analysis. Filters were fumed for 30 min over concentrated HCl, dried, and subsequently analyzed on Perkin Elmer 240 Elemental CHN analyzer. Surface sediment samples were taken by dragging a weighted aluminum cylinder (40x-10 cm) along the bottom. The depth of sediment sampled could not be accurately controlled, but material from the upper 5 cm was probably collected. Sediment was subsampled after mixing, placed in a whirl-pack bag and stored at 5°C before analysis for organic content. As soon as possible, subsamples of this material were dried at 60°C before being ground with a mortar and pestle. Sediment was stored in disposable sterile plastic Petri dishes.

Organic carbon and nitrogen in sediment samples of 500 to 800 mg dry weight were also determined using the Perkin-Elmer Elemental Analyzer. Samples were placed in preweighed vials and the dry weight determined before adding 3 mL of 1 N HCl for one hour. Vials were then placed in a desiccator in an oven (50°C) and evaporated under vacuum (20 to

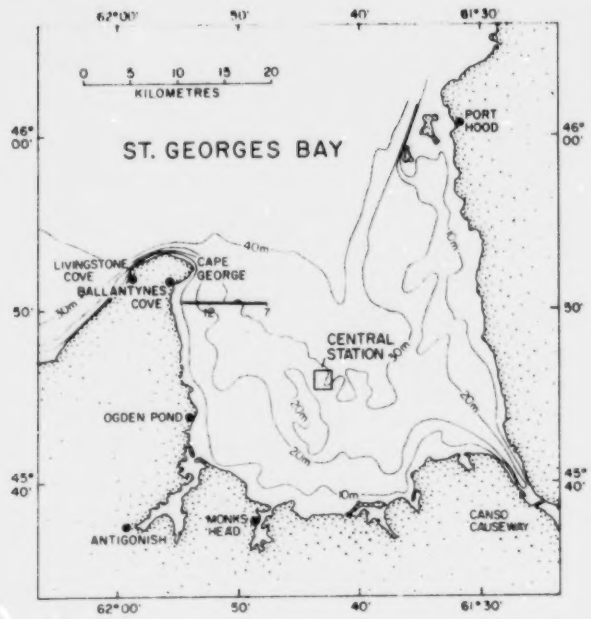

Fig. 1 St. Georges Bay - bathymetry and sampling locations. Stations 7 and 12 were the locations where temperature, salinity, dissolved nutrients, phytoplankton primary production and sedimentation were measured. Plankton biomass was measured at the central station. The beach sampling station off Crystal Cliffs was at Ogden Pond.

25 inches Hg) overnight to dryness. These samples were reweighed to determine sediment dry weight after acidification. Subsamples from this material were weighed into ashed platinum boats for combustion and elemental analysis. The amount of organic carbon in the sample before acidification was calculated using the ratio of total sample weight before and after acidification. The amount of organic carbon in the subsample before acidification was expressed as a percent of sediment dry weight. Carbon present as carbonate was not determined in this study.

Dissolved Nutrients

Subsamples (100-mL) of sea water filtered (0.45 µm Millipore) for pigment determination were placed into five acid rinsed plastic bottles which were frozen immediately and stored until analysis. Samples were analyzed for nitrate, nitrite, phosphate and silicate by standard colorimetric methods (Strickland and Parsons, 1972). Ammonia was determined by the phenol-hypochlorite method of Solorzaro (1969).

Phytoplankton Productivity

The C^{14} fixation method outlined by Strickland and Parsons (1972) was used to measure phytoplankton primary productivity. Sea water collected at each depth, sieved through 570 µm mesh to remove large predators, was placed into two light and one dark glass-stoppered 125 mL bottles. Approximately 5 µC sodium bicarbonate C^{14} was inoculated into each bottle and the bottles suspended in situ on plexiglass holders attached to a 3/16 inch stainless steel wire. Incubation at standard depths of 0, 2.5, 5, 10, and 15 m at station 12 with additional bottles at 20 and 30 m at station 7 commenced at 0900 to 1000 hr local time and ended 4 to 5 hr later. Contents of each bottle were then filtered immediately (0.45 µm Millipore filters, 25 mm diameter) and stored in glassine envelopes. Within 48 hr, each filter was placed into 10 mL of a dioxane based fluor and counted by liquid scintillation.

Incident radiation during the experimental period and the entire day was recorded on a pyroheliometer located at Crystal Cliffs by Ogden Pond. Daily carbon fixation was

calculated by dividing production rates measured at each depth by the fraction of total radiation for the day received during the incubation period. Integrated values for photosynthetic production for the water column to 15 m and 30 m depth at stations 12 and 7 were calculated as the area enclosed by the x-y coordinates plotted as vertices of a polygon.

Plankton Collection and Processing

Plankton was collected biweekly in St. Georges Bay at a centrally located station (Fig. 1) from April 26 to November 15, 1977. All collections were made after sunset to reduce the variability in catch that can arise from the daily vertical movements of plankters. Four conical plankton nets, equipped with TSK flow meters, were used to sample plankters of 25 µm to >2.035 mm in size (see net specifications in Table 1). A 1-m diameter 460 µm Nytex net was towed obliquely throughout the water column (~34 m depth) at 4 knots for 30 min. This tow was lowered and raised in a stepped fashion to ensure that all depths were equally sampled. A 3/4-m diameter 224 µm, a 1-m diameter 57 µm, and a ½-m diameter 20 µm Nytex net were towed horizontally between 5 and 10 m depth at 1 to 2 knots. The duration of tow was varied, to prevent clogging of the nets at high plankton densities, between 10 and 30 min.

The contents of each net were graded on deck with a vibrating sieve apparatus (Haver and Boecker, Fabr. Nr. 3596) which was modified with controllable water jets directed at the bottom of each sample screen. Consistent and rapid sizing of particles was achieved with this technique. The 509-1028, 1028-2035, and >2035 µm size fractions were obtained from the 460 µm net, the 250-509 m size from the 224 µm net, the 66-125 and 125-250 µm sizes from the 57 µm net, and the 25-66 and a replicate 66-125 µm size from the 20 µm net. Plankton samples were scooped from the screens with a spatula and placed in preweighed vials or jars, then stored on ice until they were frozen (-29°C) at the laboratory.

Plankton samples were thawed to room temperature and examined briefly under a dissecting microscope for abundant species. Foreign objects such as paint chips, wood and insects were removed. The whole sample was weighed fresh, then oven-dried to a constant weight at ~60°C. Subsamples of dried plankton were weighed into a 50 mL test tube and homogenized (Brinkman Polytron Blender) three times for 60 s with 30 mL hexane. At each time the mixture was centrifuged for 30 min, then the supernatant decanted through a 45 µm filter to remove fine suspensions, and collected in a preweighed round-bottom flask. Lipid weights were determined after evaporating the solvent to dryness under vacuum at 30°C.

Sedimentation

Design of sediment traps and methods of deployment and retrieval remained unchanged from those used by Prouse and Hargrave (1977). Traps were exposed for periods of approximately seven days at inshore (22 m, station 12) and offshore (33 m, Station 7) locations (Fig. 1). Four open PVC cylinders, which were clamped to the wire at various depths, were mounted in each stainless steel holder. Baffled cylinders (constructed by placing 0.64 cm, 0.87 cm, and 1.91 cm internal diameter plastic tubs in each cylinder) were placed 3 m from the bottom at station 7 and one cylinder with a cover supported on three adjustable rods was suspended 4 m from the bottom at station 12. Water was quantitatively transferred to a whirl-pack bag. Material from one trap at each depth was subsampled and filtered onto a preweighed silver filter (Selas Flotronics) for carbon and nitrogen analysis. A second subsample was placed in a vial with 15 mL 85% acetone and $MgCl_2$ solution for measurement of chlorophyll *a* and pheopigments. The material remaining in samples collected was filtered onto preweighed glass fibre filters, dried and weighed for determination of sedimentation rates as described by Prouse and Hargrave (1977). All cylinders were subsampled for carbon, nitrogen and pigments on October 18 to 25, for determinaton of variance between traps.

Table 1. Specifications of plankton nets used in St. Georges Bay.

Silk No.	Pore Size (µm)	Mouth Diameter (m)	Length of net[b]		Surface Area			
			Cylindrical Section (m)	Conical Section (m)	Mouth Opening, S_m (m^2)	Total Netting, S_n (m^2)	Pore Openings, S_p (m^2)	S_p/S_m (µm)
#2	460 ±24[a]	1	1	2	0.78	6.60	2.85	3.7
#6	224 ±6	0.75	0.75	1.5	0.44	3.77	1.41	3.2
#20	57 ±3	1	1	2	0.78	6.60	1.82	2.3
	20 ±1	0.5	0.5	1	0.2	1.73	0.43	2.2

a mean ± standard deviation

b all nets have a frontal cylindrical section the same diameter as the mouth opening, followed by a conical section terminating at a canvas cod-end of 10 cm diameter

RESULTS AND DISCUSSION

Results are recorded in Appendices I to V. The following sections briefly summarize the observations and provide preliminary interpretation of results.

I. PHYSICAL OCEANOGRAPHY
(K. Drinkwater and G. Taylor)

Temperature, Salinity Characteristics

During the spring and summer the water column in St. Georges Bay is vertically stratified with a relatively homogeneous upper layer above a continuously stratified bottom layer. The waters in the upper layer, as measured at Station 7, warmed from less than 0°C in early May to over 20°C in August (Fig. 2). Comparison of data collected in 1976-76 (Petrie and Drinkwater, 1977a,b; Drinkwater and Taylor, 1979) indicate that surface waters during 1977 were cooler than normal during June to mid-July but reached normal peak temperatures. Near bottom temperatures (30 m) rose to a peak of 7°C in mid-July, declined to 4°C by late August, and finally increased to a maximum of over 10°C when the Bay became vertically homogeneous in October. Surface salinities were relatively constant at 29.2°/$_{oo}$ from mid-May to mid-June before dropping to a minimum of 28.5°/$_{oo}$ in late August, early September. This minimum coincides in time with the expected arrival of the peak discharge from the St. Lawrence River system (Lauzier, 1953; Sutcliffe et al., 1976). Near bottom salinities generally varied between 30.0°/$_{oo}$ and 30.7°/$_{oo}$ through the summer until October when salinities decreased to 29.0°/$_{oo}$. Surface temperature and salinity at station 12 (Fig. 3) were similar to those measured at station 7; however, the shallower near bottom values at 12 (20 m) more closely resembled the surface waters than the bottom temperature and salinity patterns at station 7.

The depth of the upper or mixed layer at station 7 increased from early June through to October when the water became homogeneous top to bottom (Fig. 4). The depths plotted in Fig. 4 correspond to the bottom of the homogeneous temperature layer. Owing to the small vertical salinity gradients, temperature gradients generally coincided with those of density.

The slope of the least squares fit of depth versus time was 0.14 m/d. This is lower than the 0.20 m/d in 1974 and the 0.19 m/d in 1976; however, the mixed layer was deeper at the beginning of June in 1977 than in the other two years. Prior to June a stable pycnocline had not developed similar again to events in previous years. The rate of increase of the depth of the mixed layer in the Bay corresponds to Lauzier et al.'s (1957) for the southeastern coastal regions of the Magdalen Shallows. As the mixed layer depth increased from June to November so also did the surface area of the sea floor in contact with the mixed layer (Fig. 5, Table 2).

Although seasonal changes in temperature and salinity at station 7 may be assumed to be representative of the Bay, horizontal gradients in temperature and salinity do exist within the Bay. Transects across the length and breadth of the Bay during July revealed a lens of lighter, warmer water at the centre surrounded by cooler water (by 1°C) with warmer water again close into shore. This temperature structure has been observed in other years (Petrie and Drinkwater, 1977b) and it is consistent with the existence of a clockwise gyre in the upper layer. Such a gyre has been observed with current meters (Petrie and Drinkwater, 1978a).

Horizontal gradients in water properties were also observed between the Bay and Northumberland Strait. Measurements on June 23 revealed water 2°C colder and 0.5°/$_{oo}$ more saline in the Strait off Livingstone Cove compared to water in the Bay. The duration of these temperature, salinity differences are unknown but the data do suggest water from the Strait did not enter directly into the Bay. Small gradients were observed between the Strait and the Bay on July 12.

Currents

During mid-July to mid-August four Aanderaa current meters were moored at station 7 and one at station 12 on the Ballantynes Cove transect in conjunction with sediment traps. Only the first few days of the current record at station 12 (18 m) were uncontaminated by marine fouling. No record was obtained at the upper current meter (8 m) at station 7 through instrument failure. Good data was obtained from the three remaining instruments at station 7 located at 21, 26, and 30 m. Current records with the tides removed and filtered to 6 hr averages are plotted in a stick diagram (Fig. 6) where the length is proportional to the amplitude of the current and the direction is that towards which the current is flowing. Periods of above average rates (events) often occurred simultaneously at all three depths (e.g. days 206, 210, 213, 222); however, the amplitude decreased with increasing depth and the directions were not always uniform. These events did not correspond with any local wind event but did occur during the passage of low pressure systems (Drinkwater and Taylor, 1979).

Mean currents over the duration of the records were 2 cm s^{-1} to the west-northwest at 21 m, 1 cm s^{-1} to the northeast at 26 m, and 0.4 cm s^{-1} to the west-southwest at 30 m. Current fluctuations of amplitude 5 to 10 times the mean and periods of 1 to 2 d occur

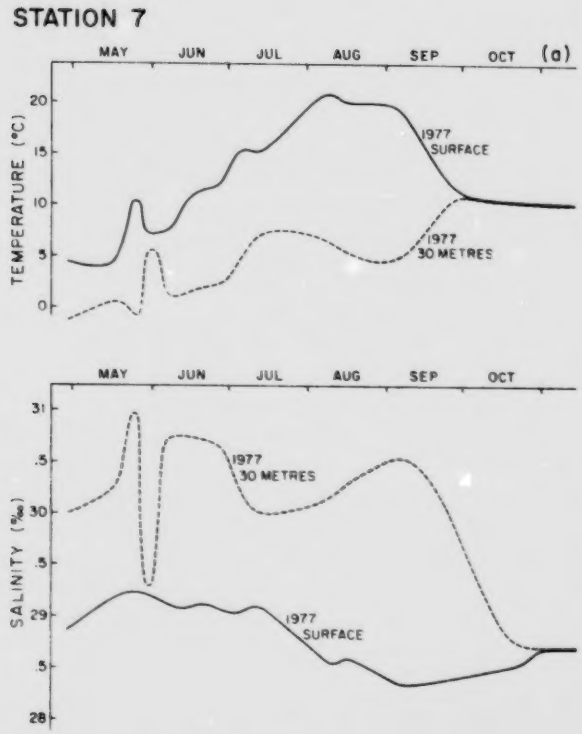

Fig. 2. Time series of temperature and salinity changes at 0 and 30 m at station 7 in St. Georges Bay during 1977.

Table 2. Seasonal change in the percentage of the sea floor of St. Georges Bay in contact with the upper mixed layer.

Month	Approximate Depth of Mixed Layer (m)	Sea Floor Area (km^2)	% of Total SGB Area
June	10	122	12
July	15	246	24
August	20	375	36
September	25	591	58
October	30	722	70
November	35	869	84

at all depths.

Surface currents were investigated using surface bottle drifters. Of the 396 surface drifters released along Ballantynes Cove transect over the field season 75 were recovered. Forty-five were found in the Bay and the remainder were located along the Gulf of St. Lawrence side of Cape Breton Island (28), in Newfoundland (8), or along the southern end of Canso Strait or Chedabucto Bay (5). The latter five drifters probably were carried through the lock at the Canso Causeway. The overall results were similar to those of 1974 and 1975 (Petrie and Drinkwater, 1977a,b). Of the 50 drifters released off Livingstone Cove on July 12, 11 were recovered, 8 along the northwest coast of Cape Breton and 3 off southern Newfoundland. The drift bottle results indicated a mean surface speed of approximately 12 cm s^{-1} to the northeast past the mouth of the Bay and along the coast of Cape Breton. Surface speeds within the Bay were approximately 6 cm s^{-1}.

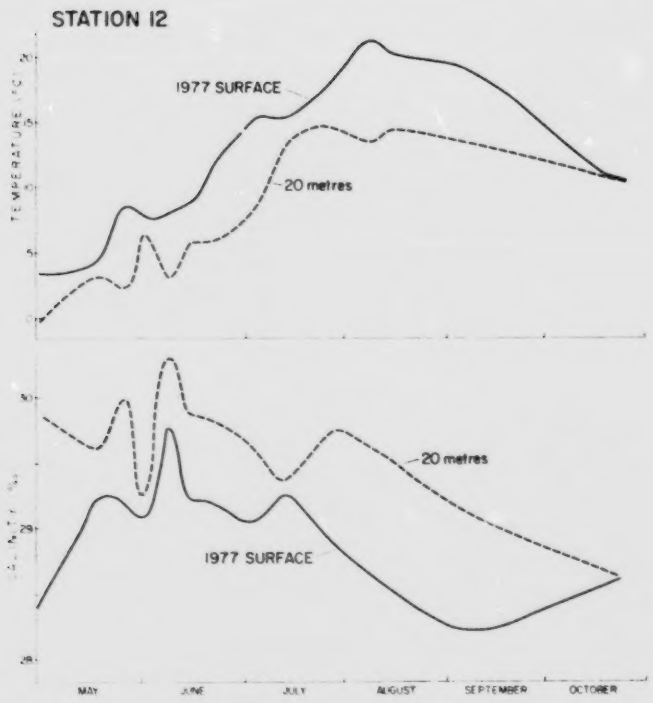

Fig. 3. Time series of temperature and salinity changes at 0 and 20 m at station 12 in St. Georges Bay during 1977.

The clockwise gyre observed previously in the upper layers of the Bay (Petrie and Drinkwater, 1978a) probably existed in 1977. This is supported by the measured horizontal temperature and salinity gradients and the drift bottle results. The eastward flow past the Bay, as observed by the drift bottles, has been shown to be the primary force in generating the gyre (Petrie and Drinwkater, 1978b).

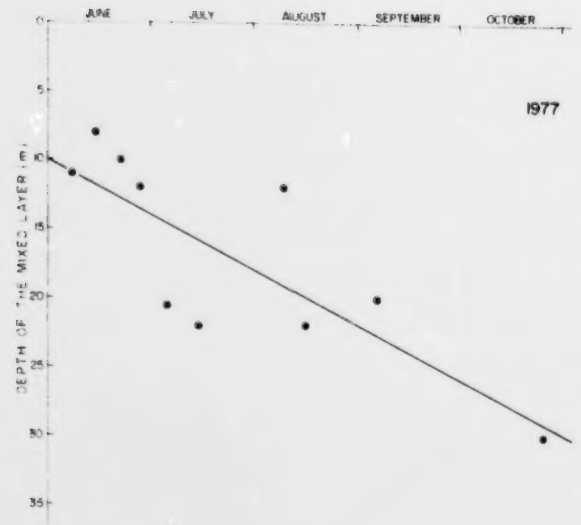

Fig. 4. Seasonal changes in depth of the mixed layer in St. Georges Bay during 1977.

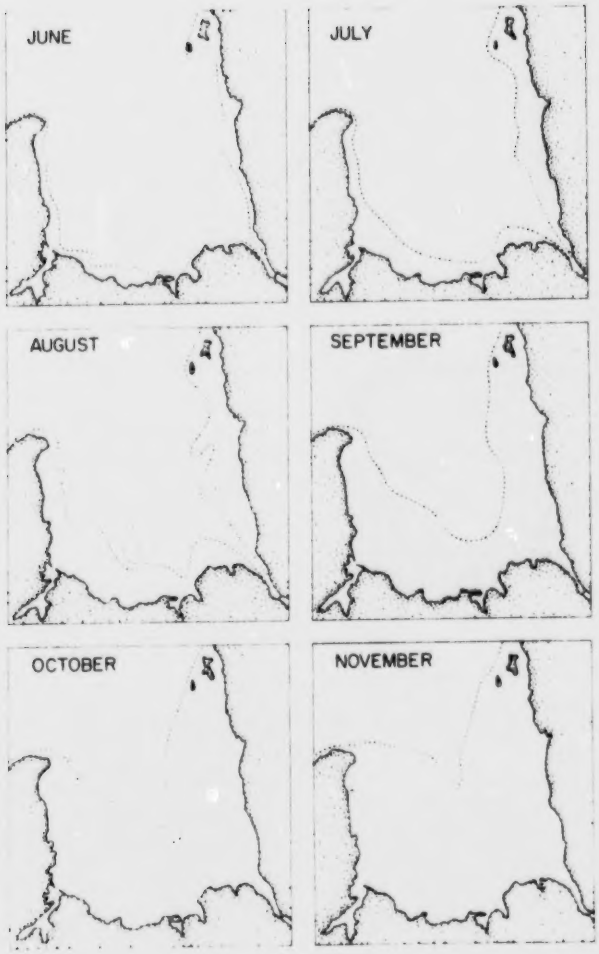

Fig. 5. The areas of the sea floor in St. Georges Bay in contact with the upper mixed layer from June to November 1977.

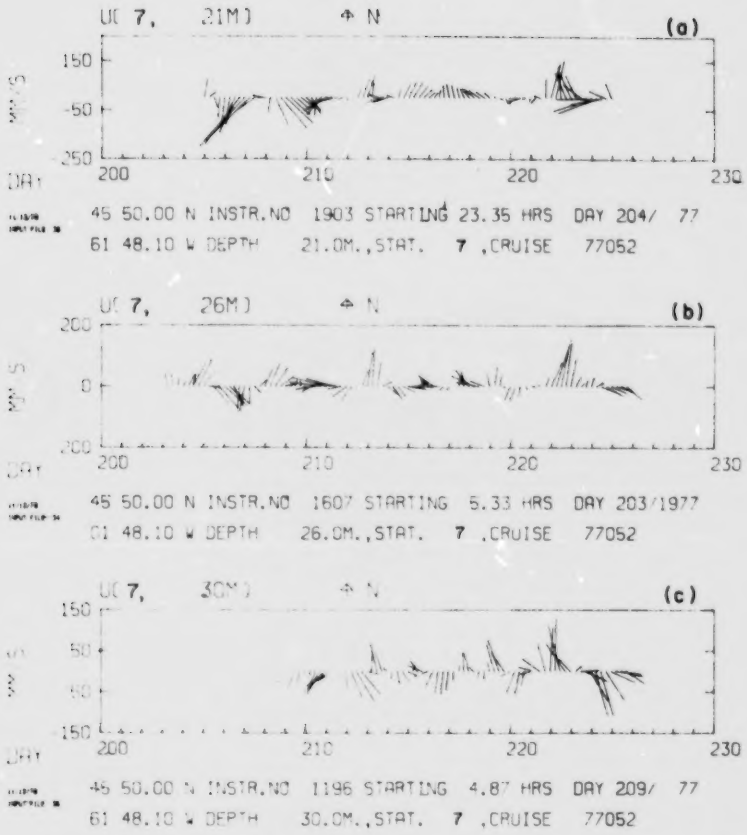

Fig. 6. Six-hour average currents at (a) 21 m, (b) 26 m, and (c) 30 m at station 7 in St. Georges Bay mid-July to mid-August 1977.

2. DISSOLVED NUTRIENTS
(C. Harrison)

Nutrient Concentrations

A representative vertical profile is illustrated in Fig. 7. Nutrient concentrations in the euphotic zone (15 m) were relatively uniform and low. A pronounced nutricline was observed at 20 m depth at station 7 but this was usually absent at station 12. Concentrations of all nutrients increased in a continuous gradient below the nutricline, on most sampling dates. This general characteristic of profiles at station 7 persisted throughout most of the sampling period until late October when nutrient concentrations were high and uniform throughout the water column.

On a seasonal basis, changes in individual nutrient concentrations differed. When expressed as total concentration in the water column (mg-at m^{-2}), nitrate, nitrite, and phosphate changed very little throughout the summer. Nitrate and nitrite showed a significant increase in th fall (Fig. 8). This pattern was the same for both stations. Silicate concentrations increased throughout the entire sampling period while ammonia showed a pronounced peak in summer (late July and August). These patterns were evident at both stations.

Concentrations of nutrients computed for the upper 15 m for both stations showed the same general seasonal trends (Fig. 9). On most sampling dates, however, nitrate, nitrite and phosphate concentrations were slightly higher and silicate was consistently higher at the shallow station. Ammonia concentrations, on the other hand, were significantly higher at the deep station in summer. Nutrient concentrations for both stations converged by late October.

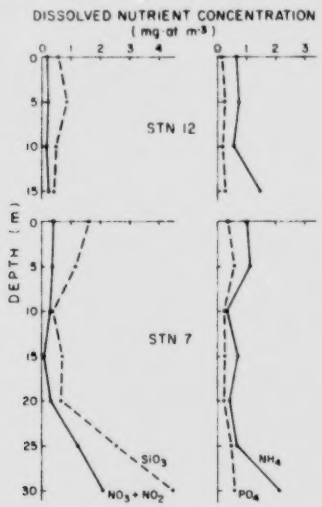

Fig. 7. Vertical profiles of dissolved inorganic nutrients, stations 12 and 7, May 15, 1977, in St. Georges Bay.

Nutrient Ratios

Plots of the relationship between nutrient concentrations in waters below the nutricline (20 to 30 m, station 7) were used to consider relative changes in concentration of nutrients over time. Linear regressions of total inorganic nitrogen on silicate and phosphate were significant and positively correlated, having slopes of 0.4 and 5.9, respectively (Fig. 10). Nutrient ratios were also computed for waters above the nutricline (Table 3). Mean nitrogen/silicate ratios were slightly higher (0.6) than in the deeper waters while nitrogen/phosphate ratios were essentially the same (5.9). Of the three forms of inorganic nitrogen measured, ammonia was, on the average, the most abundant. The mean ammonia/ nitrate plus nitrite ratio was 4.3 but values exceeded 10 during August.

Conclusions

It was apparent fom the uniformly low nutrient concentrations in the euphotic zone when sampling was initiated (25 May) that the spring phytoplankton bloom had already

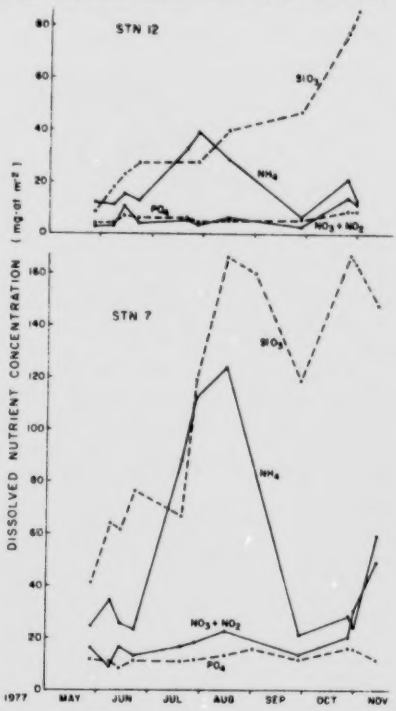

Fig. 8. Seasonal changes in total concentrations of dissolved inorganic nutrients integrated to 15 m at Station 12 and 30 m at station 7.

Table 3. Ratios of integrated concentrations (mg-at m^{-2}) of dissolved nutrients in the upper 20 m at station 7 in St. Georges Bay (May-November 1977). Absolute values given in Table 4. N calculated as $NO_3 + NO_2 + NH_4$.

Date	SiO_3/NO_3+NO_2	$NO_3 + NO_2/PO_4$	NH_4/NO_3+NO_2	N/PO_4	N/SiO_4
25/5	3.14	0.70	2.85	2.70	1.23
7/6	6.73	0.74	5.24	4.60	0.93
14/6	2.58	2.15	1.14	4.59	0.83
21/6	4.21	1.02	1.91	2.98	0.69
28/6	3.64	1.05	3.2	4.39	1.16
18/6	2.98	1.41	5.75	9.50	2.27
2/8	7.00	1.08	13.95	16.12	2.13
15/8	6.56	1.18	9.34	12.17	1.59
28/9	13.56	0.47	1.92	1.37	0.21
25/10	6.97	1.39	1.24	3.12	0.32
14/11	5.31	1.94	0.77	3.43	0.33
Median	5.31	1.08	2.85	4.39	0.93
Mean	5.70	1.19	4.30	5.91	0.62
	3.12	0.51	4.10	4.64	1.37

occurred. The pattern of low nutrient concentrations above 20 m throughout the summer and early fall is typical of highly stratified coastal waters in summer. An exception to this general pattern was observed in ammonia and silicate concentrations. Maximum ammonia concentrations in excess of 5 mg-at m^{-3} occurred during summer in the euphotic zone. Concentrations this high are not normally observed in surface waters unpolluted by domestic or industrial wastes. Also, in most coastal waters a clear seasonal pattern of changes in concentrations is usually not observed. Ammonia concentrations increased markedly during July after maximum levels of zooplankton biomass had occurred (see Section 4).

Silicate concentrations generally increased throughout the period of observation. A continuous increase throughout the summer and fall was not observed for any of the other nutrients and this pattern could not be related to any changes in either phytoplankton or zooplankton abundance. Since net accumulation with time was apparent, processes producing silicate in the euphotic zone must have

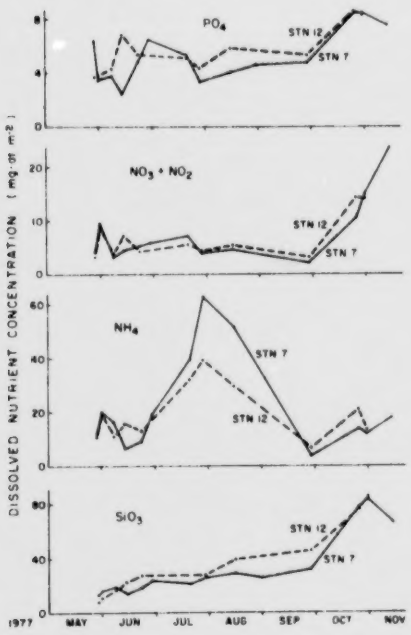

Fig. 9. Comparison of seasonal changes in total concentrations of dissolved inorganic nutrients integrated to 15 m depth at stations 7 and 12. Shaded area indicates times when concentrations at station 12 exceeded those of station 7.

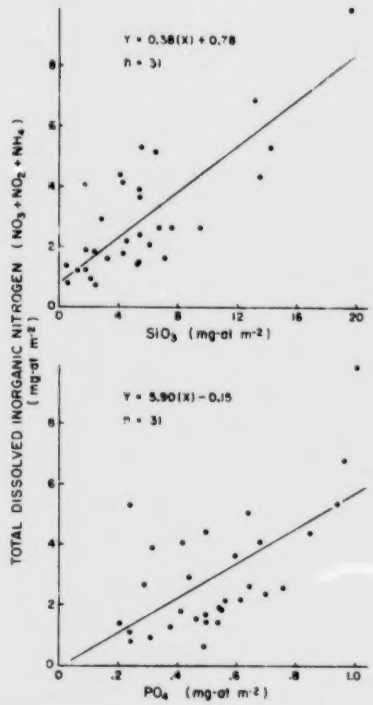

Fig. 10. Comparison of total silicate and phosphate concentration to total dissolved inorganic nitrogen integrated between 20 and 30 m at station 7. Data are presented in Table 4.

exceeded biological utilization. Possibly a combination of deepening of the thermocline (see Section 1), mixing more of the silicate rich deeper water into the euphotic zone, and biological succession from silicate requiring diatoms in spring to non-utilizers (e.g. dinoflagellates) in summer and fall could have contributed to the observed pattern.

Finally the questions of which nutrient(s) are limiting primary production in St. Georges Bay and the importance of nutrients in general in regulating production may be partially answered from observations of nutrient ratios in the deeper "source waters" and in the euphotic zone. N/SiO_3 and N/PO_4 ratios of both shallow and deeper waters in St. Georges Bay are significantly less than normal compositional ratios of these elements in marine phytoplankton. In other words, both silicate and phosphate were apparently in excess of growth requirements for phytoplankton when compared to nitrogen. Also, extrapolation of the N to SiO_3 and N to PO_4 regression lines results in positive SiO_3 and PO_4 intercepts, implying that these nutrients would be present when the nitrogen was exhausted. These observations suggest that nitrogen was probably limiting, as is commonly the case in coastal marine waters.

Assuming nitrogen is an important nutrient to consider for primary production its availability to phytoplankton in St. Georges Bay would be dependent on mixing of nutrient-rich deep waters (into the euphotic zone) and /or regenerative processes *in situ* (within the euphotic zone). The first mechanism at present may be difficult to quantify, although we can infer from the relatively uniform nature of the nutricline throughout the summer that consumption at least matched supply to the euphotic zone.

By comparing the distribution of nutrients above and below the nutricline over time, we may be able to assess the importance of *in situ* regeneration. Table 4 illustrates calculations which show that at station 7 up until the water column was well mixed in fall 40% of nitrate plus nitrite and silicate were found in the upper 20 m and the remaining 60% was in the lower 10 m. In contrast, 50% or more of the phosphate and ammonia were found in the upper 20 m. Under well mixed conditions, 2/3 of all nutrients were in the upper 20 m and 1/3 in the lower 10 m as would be expected. Because more ammonia and phosphate were found in the euphotic zone than expected from the distribution of other nutrients and because these nutrients are commonly considered to be rapidly recycled, the evidence strongly suggests their originating from *in situ* regeneration. Based on an estimated C:N assimilation ratio of 7 (molar basis), the average concentration of nitrogen in the euphotic zone for the period May through October could have sustained the mean production rates observed for that period for approximately 8 days at both the shallow and deep stations.

Table 4. Integrated concentrations of dissolved nutrients (mg-at m^{-2}) above and below 20 m at station 7 in St. Georges Bay (May-November 1977). * indicates period of a relative homogeneous water column. Numbers in parentheses express concentrations of each nutrient above and below 20 m as percentage of the total concentration in the water column. $\bar{X}_s$ is the average percentage value during periods of stratification (May to September). $\bar{X}_t$ is the average during homogeneous conditions (October to November).

Date 1977	$NO_2 + NO_3$		SiO_3		PO_4		NH_4	
	0-20	20-30	0-20	20-30	0-20	20-30	0-20	20-30
25/5	5.30	11.35	16.63	25.07	7.58	5.02	15.13	9.75
	(32)	(68)	(40)	(60)	(60)	(40)	(61)	(39)
7/6	4.15	5.35	27.95	36.35	5.63	5.40	21.75	13.10
	(44)	(56)	(43)	(57)	(51)	(49)	(62)	(38)
14/6	7.38	9.62	19.05	42.75	3.43	5.30	8.38	17.17
	(43)	(57)	(31)	(69)	(39)	(61)	(33)	(67)
21/6	7.05	5.98	29.68	46.30	6.90	5.48	13.50	9.85
	(54)	(46)	(39)	(61)	(56)	(44)	(58)	(42)
18/7	9.99	7.45	29.73	36.95	7.10	5.05	57.45	31.35
	(57)	(43)	(45)	(55)	(58)	(42)	(65)	(35)
26/7	5.49	12.85	38.43	80.70	5.09	7.79	76.56	36.20
	(30)	(70)	(32)	(68)	(40)	(60)	(68)	(32)
15/8	7.31	15.20	47.96	118.20	6.21	7.60	68.26	55.85
	(32)	(68)	(29)	(71)	(45)	(55)	(55)	(45)
28/9	3.00	10.95	40.69	78.45	6.38	5.80	5.76	15.60
	(22)	(78)	(34)	(66)	(52)	(48)	(27)	(73)
*25/10	15.13	5.25	105.43	62.10	10.85	5.03	18.73	9.75
	(74)	(26)	(63)	(37)	(68)	(32)	(66)	(34)
*31/11	20.25	10.70	107.45	51.70	10.45	4.85	15.63	9.05
	(65)	(35)	(68)	(32)	(68)	(32)	(63)	(37)
*14/11	29.90	10.98	96.15	51.783	9.60	3.00	26.80	33.10
	(73)	(27)	(65)	(35)	(76)	(24)	(45)	(55)
$\bar{X}_s$	(39)	(61)	(37)	(63)	(50)	(50)	(54)	(46)
$\bar{X}_t$	(71)	(29)	(65)	(35)	(71)	(29)	(58)	(42)

3. PHYTOPLANKTON PRODUCTION AND SUSPENDED PLANT PIGMENTS
(N. Prouse and B. Hargrave)

Chlorophyll a and pheopigment concentrations integrated over the entire water column at both stations decreased initially during May then increased irregularly during the summer to reach maximum concentrations on September 28 and October 18 (Table 5, Fig. 11). Changes in chlorophyll a concentration during the summer were characterized by peaks on June 7, July 18, and August 15. Changes in pheopigment concentration were not as regular. Similarly phytoplankton carbon fixation, although initially low during May, increased with fluctuations during the summer to reach maximum rates at both stations on September 28 which subsequently decreased (Fig. 12). Changes in chlorophyll a concentrations and rate of primary production in surface water at stations 7 and 12, and off Crystal Cliffs beach a Ogden Pond, were similar throughout the summer and fall (Fig. 13). All measures increased rapidly during early June and then progressive ly increased (with fluctuations) during the summer to maximum values in September and October.

Maximum rates of phytoplankton carbon fixation occurred between the surface and 10 m while highest concentrations of chlorophyll a were usually found at deeper depths (Appendix I). Thus, greater integrated chlorophyll a concentrations generally occurred at Station 7 (Fig. 11). This was not associated with higher rates of carbon fixation, since both stations showed similar absolute rates and seasonal trends in specific phytoplankton production (Fig. 14). Initial high concentrations of chlorophyll a, especially near the bottom at both stations on April 28 (Appendix I), imply that an earlier bloom of phytoplankton had settled to this depth. Seasonal maximum concentrations of pheopigments at station 7 on April 28 (Fig. 11) support the idea that a phytoplankton bloom preceded the first sampling date.

Estimates of phytoplankton primary production for the six month period of observation integrated over 15 m at station 12 and 30 m at station 7 were similar (Table 6). Integration of phytoplankton producton to 15 m

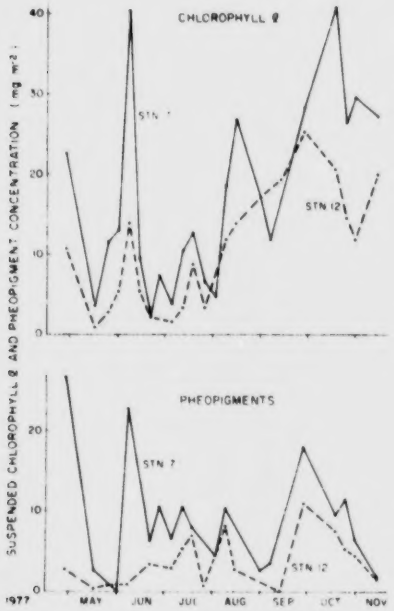

Fig. 11. Seasonal changes in total concentra tions of chlorophyll a and pheopigments integrated over 15 m and 30 m at stations 7 and 12 respectively in St. Georges Bay during 1977.

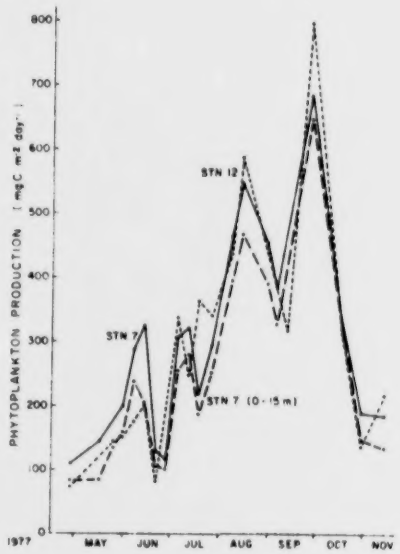

Fig. 12. Seasonal changes in phytoplankton primary production at stations 7 and 12 in St. Georges Bay during 1977. Integral primary production is calculated to 15 m and 30 m for station 7 for comparison with integrated production to 15 m for station 12.

depth at station 7 produced a six month total which was 12% lower than that measured at station 12. Monthly averages of integrated chlorophyll a concentrations, compared on the same basis, demonstrate the abundance in chlorophyll a below 15 m at station 7. Above 15 m, however, average chlorophyll a concentrations were similar from May to July, with differences occurring between stations in following months. Comparison of integrated values of dissolved nutrients and particulate carbon and nitrogen over the 0 to 15 m depth interval at both stations listed in Table 5 also illustrates that concentrations per unit area and volume at both stations were generally similar throughout the study.

Carbon fixation was compared with incident light and integrated chlorophyll a concentration using stepwise linear regression analysis (Table 7). Variation in chlorophyll a concentration accounted for the most variation in production at both stations, but the relationship was only significant at station 12 where 32% of the variation in phytoplankton carbon fixation was attributable to changes in chlorophyll a concentrations. There was no significant correlation between either chlorophyll a concentration or incident radiation and production at station 7 where carbon fixation was integrated over 15 and 30 m. When normalized for light intensity, phytoplankton carbon fixation rates for the six month period integrated over 15 m averaged 11.62 mgC cal^{-1} x 10^{-5} at station 12 and 10.79 mgC cal^{-1} x 10^{-5} at station 7 (Table 8).

Specific production by phytoplankton (calculated as the ratio of hourly carbon fixation: chlorophyll a concentration integrated over the same depth interval) showed that photosynthesis was most efficient during early July at station 12 (Fig. 14). Low chlorophyll a concentrations and relatively high rates of carbon fixation occurred during this period (Fig. 11 and 12). A peak in specific production did not occur at station 7 at this time, however. Rather, there were alternate increases and decreases in values of specific production throughout the summer with decreased values after August. These seasonal changes resulted in an inverse relation between chlorophyll a concentration and phytoplankton specific production (Fig. 15). Highest rates of specific production occurred during periods of low chlorophyll a concentration.

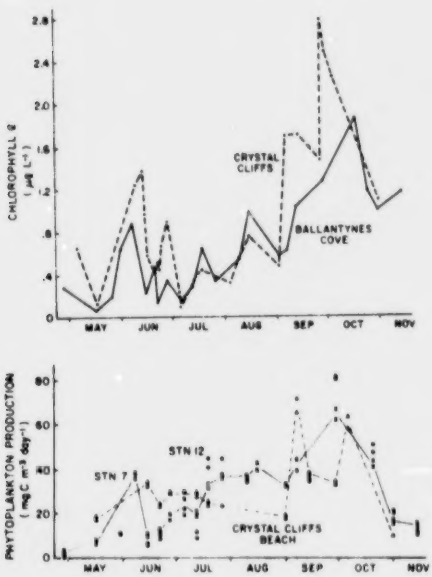

Fig. 13. Seasonal changes in chlorophyll a concentration and phytoplankton primary production in surface water along the transect off Ballantynes Cove, at two stations (7 and 12) along the transect and off Crystal Cliffs beach at Ogden Pond, St. Georges Bay.

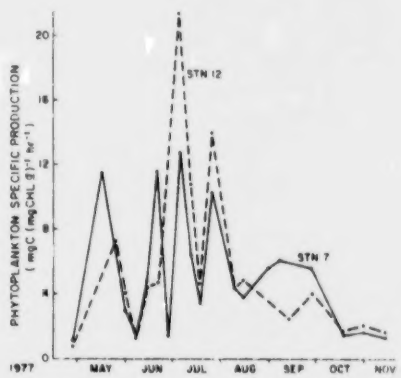

Fig. 14. Seasonal changes in depth integrated (0-15 m) hourly phytoplankton carbon fixation normalized for chlorophyll concentration (specific production) at stations 7 and 12.

Table 5a. Concentrations of nutrients, plant pigments, suspended carbon and nitrogen and values of phytoplankton primary production and dark uptake integrated between 0 and 15 m in St. Georges Bay at stations 7 and 12 during 1977.

Date	Station No.	Nitrate	Nitrite	Ammonia	Phosphate	Silicate	Chlorophyll a
		mg-at N m^{-2}	mg-at N m^{-2}	mg-at N m^{-2}	mg-at P m^{-2}	mg-at Si m^{-2}	mg m^{-2}
April 28	7						9.35
	12						10.68
May 16	7						1.11
	12						0.80
May 25	7	2.63	1.68	12.03	6.25	13.20	2.70
	12	2.65	0.75	11.50	3.60	9.25	2.63
May 30	7	8.56	1.00	20.00	3.45	15.43	7.28
	12	6.78	1.48	19.55	3.70	10.80	5.28
June 7	7	3.10		16.53	3.85	19.23	17.18
	12	2.83	1.00	10.50	4.13	18.53	13.98
June 14	7	4.20	0.58	5.90	2.40	13.08	5.19
	12	6.95	0.45	15.50	6.93	22.63	5.38
June 21	7	4.75	0.35	9.65	4.80	18.48	1.23
	12	3.50	0.85	13.13	5.28	27.45	2.11
June 27	7	5.58	0.60	19.73	5.61	22.36	4.95
July 5	7						2.08
	12						1.50
July 12	7						5.41
	12						3.25
July 18	7	6.81	0.63	39.80	5.13	21.13	6.08
	12	5.13	0.48	32.13	5.08		8.74
July 26	7	3.43	0.46	62.69	3.15	25.53	2.83
	12	3.50	0.45	39.08	4.28	27.73	3.28
August 2	7						3.00
August 9	7						10.14
	12						11.83
August 15	7	4.14	0.65	50.99	4.04	29.41	13.53
	12	4.81	0.73	29.61	5.91	39.89	13.64
September 1	7		0.54		4.65	26.01	9.11
September 6	7						7.08
September 13	12						17.28
September 19	7						
September 28	7	1.84	0.46	2.96	4.85	30.89	13.93
	12	2.84	0.70	6.51	5.24	46.85	25.25
October 3	7						
October 18	7						27.75
	12						20.58
October 25	7	9.05	1.90	14.28	8.28	78.73	15.15
	12	12.50	1.65	21.30	8.33	77.28	14.45
October 31	7	13.28	1.75	11.78	8.25	84.38	16.43
	12	12.15	2.00	12.43	8.23	85.38	11.93
November 14	7	23.40		17.80	7.55	65.50	15.23
	12						19.90
December 21	7	20.65	1.13	13.5	3.70	91.98	22.80

Table 5b. Concentrations of nutrients, plant pigments, suspended carbon and nitrogen and values of phytoplankton primary production and dark uptake integrated between 0 and 15 m in St. Georges Bay at stations 7 and 12 during 1977.

Date	Station No.	Pheo-pigments	Phytoplankton Primary Production		Dark Uptake	Particulate Carbon	Particulate Nitrogen	Average Primary Production
		mg m^{-2}	mgC m^{-2} d^{-1}		mgC m^{-2} d^{-1}	mgC m^{-2}	mgC m^{-2}	mgC m^{-2}
April 28	7	11.78	82.80	78.89	26.91			80.8
	12	2.83	71.88		53.22			71.9
May 16	7	0.50	86.59	73.06	35.21			79.8
	12	0.37						
May 25	7	-						
	12	0.83	156.40	125.58	42.10			140.9
May 30	7	-	189.50	123.75	25.68			156.6
	12	1.70	152.65	153.15	31.08			152.9
June 7	7	1.43	243.93	235.83	45.00			239.9
	12	0.98	193.05	157.30	42.85			175.2
June 14		-	193.98	209.33	36.16	1744.5	222.5	201.0
	12		196.71	203.31	49.23			200.0
June 21	7	1.99	99.49	112.08	29.50	740.1	112.9	105.8
	12	3.21	52.55	107.88	277.35			80.2
June 27	7	5.06	97.46	105.24	64.70			101.4
July 5	7		273.09	238.20	61.93			255.6
	12	2.69	375.35	351.00	59.18			338.2
July 12	7	4.81	280.01	277.05	36.24	1863.5	442.0	278.5
	12	5.25	241.39	257.85	47.91			249.6
July 18	7	3.50	190.19	186.76	132.80			188.5
	12	6.85	369.08	357.66	160.73			363.4
July 26	7	-	218.96	286.71	51.30	1389.2	177.8	252.8
	12	0.64	359.10	321.19	69.71			340.2
August 2	7	1.55						
August 9	7	3.21	386.20	424.45	122.33			396.3
	12	8.16	470.15	401.15	81.45			435.7
August 15	7	-	500.28	437.48	98.95			468.9
	12	2.78	582.16	591.63	149.71			586.9
September 1	7	1.13	396.36	391.39	60.69			393.9
September 6	7	1.85	313.13	341.48	115.08			327.3
September 13	12		295.35	297.55	42.83			296.5
September 19	7					2609.8	296.3	
September 28	7	11.04	668.54	630.54	897.88	1320.3	162.8	649.5
	12	10.68	755.08	840.80	740.40			797.9
October 3						380[illegible]	182.5	
October 18	7	-	320.10	289.20	822.4	1615.8	215.0	304.6
	12	7.53	291.88	277.60	869.88			284.7
October 25	7	6.25				1811.0	210.8	
	12	5.18						
October 31		2.00	183.70	115.10	393.38	1193.5	103.3	149.4
	12	4.40	134.18	140.13	811.20			137.2
November 14	7	-	123.93	146.73	389.50	1592.2	377.2	135.3
	12	1.85	238.91	193.11	374.11			216.0
December 21	7	11.23				4599.1	462.5	

Table 6. Monthly integrated phytoplankton primary production and average chlorophyll *a* concentrations at two stations in St. Georges Bay during 1977.

	Phytoplankton Production g C m^{-2} $month^{-1}$			Average Chlorophyll *a* mg m^{-2}		
Station	7	7	12	7	7	12
Depth of Integration (m)	0-30	0-15	0-15	0-30	0-15	0-15
May	4.6	3.2	3.7	9.2	3.7	2.9
June	6.7	5.1	4.8	14.8	7.1	7.2
July	8.7	7.4	9.9	8.3	4.1	4.2
August	14.7	12.7	14.9	16.7	8.9	2.7
September	15.5	14.0	15.1	19.3	10.0	21.3
October	12.1	11.1	12.5	32.3	19.8	15.7
6 month total	62.3	53.5	60.4			

Table 7. Stepwise linear regression analysis comparing integrated chlorophyll *a* concentration, hourly incident radiation at the surface and phytoplankton production over a six-month period at two stations in St. Georges Bay. Data presented in Appendix I.

	Chlorophyll mg Chl *a* m^{-2}		Incident Radiation Kcal m^{-2} hr^{-1}	
	b	R^2	b	R^2
Primary Production ($mg\ C\ m^{-2}\ hr^{-1}$)				
Station 12 (0-15 m)	2.238	0.317*	0.047	0.515*
Station 7 (0-15 m)	1.317	0.144	0.028	0.245
Station 7	0.671	0.117	0.026	0.199

* significant ($p < 0.05$)

Table 8. Phytoplankton primary production integrated over 15 m at stations 7 and 12 normalized for light intensity, St. Georges Bay, 1977.

Date	mgC cal^{-1}x10^{-5} Station 7	Station 12
April 28	1.42	1.27
May 16	1.56	
May 25		3.52
May 30	3.16	3.09
June 7	27.98	20.44
June 14	8.77	8.69
June 21	6.65	5.15
June 27	1.91	
July 5	4.26	5.65
July 12	5.56	4.99
July 18	10.47	20.19
July 26	4.29	5.77
August 9	8.63	9.49
August 15	8.21	10.28
September 1	9.29	
September 7	16.49	
September 13		11.15
September 28	15.80	19.42
October 18	54.39	50.84
October 31	7.29	6.69
November 14	6.84	10.91
Average	10.79	11.62

The increase in chlorophyll a concentration and carbon fixation during September and October corresponded to an increase in concentration of all nutrients in the water column (Table 5). On September 28, the depth of the mixed layer at station 7 was 25 m (Section 1 and Appendix I). Thus, nutrient supply to surface water would have been high at this time. Although the efficiency of photosynthesis was low in late September (Fig. 15), this was the time of maximum rates of phytoplankton production (Fig. 12).

Suspended chlorophyll a and pheopigment concentrations measured at the surface along the transect were slightly higher inshore during June and offshore in October (Fig. 16 and 17). Concentrations were more homogeneous between inshore and offshore stations during the summer. A much higher percentage of the total pigment was present as chlorophyll a during early summer (80-100%) than during the fall when concentrations of pheopigments increased (Fig. 18).

Secchi depth observations indicated that concentrations of suspended material were least during the spring at all stations along the transect (Appendix I). Turbidity increased during early summer and then remained constant during the fall. No difference in secchi disc visibility between inshore and offshore stations could be detected at any time during the six months of observations.

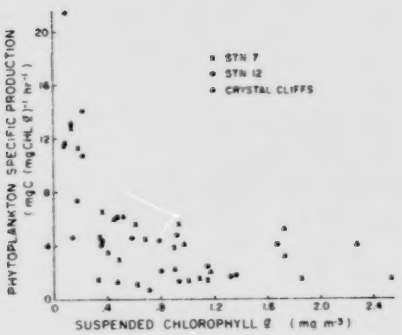

Fig. 15. Comparison of specific primary production by phytoplankton and chlorophyll a concentration at three locations in St. Georges Bay sampled from April to November 1977.

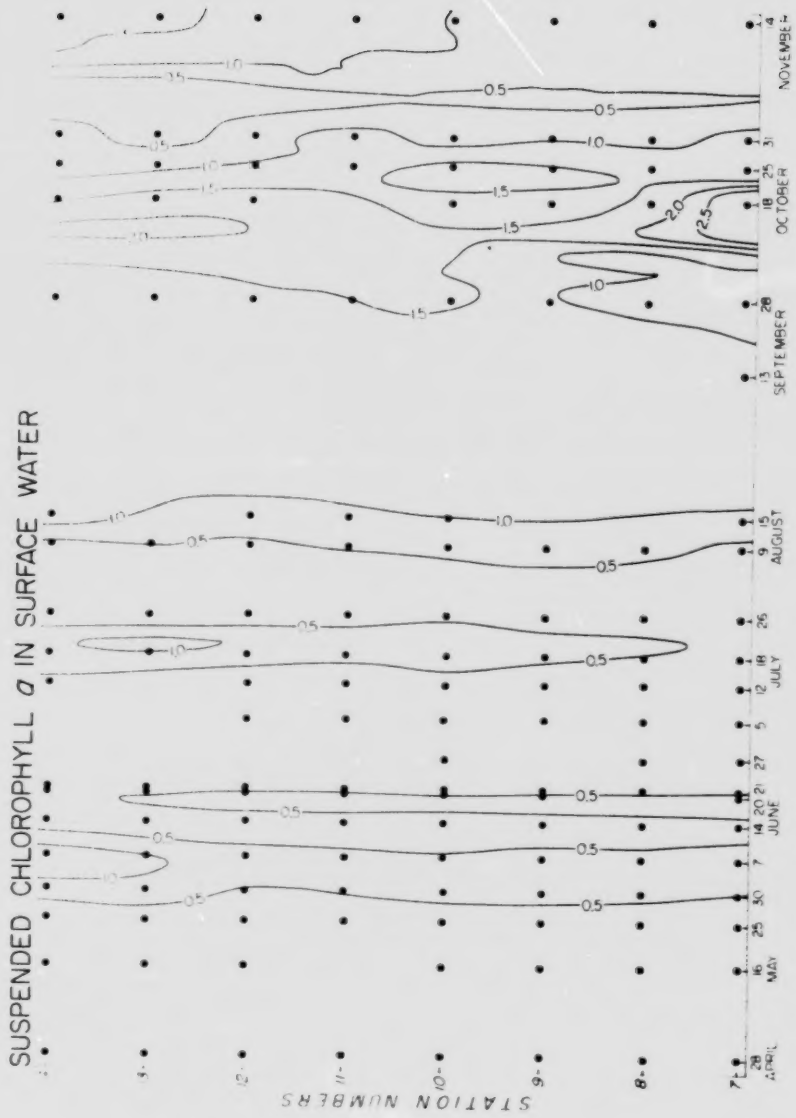

Fig. 16. Concentrations of chlorophyll a in surface water sampled along the transect off Ballantynes Cove (see Fig. 1). Sampling stations (indicated by number) located one nautical mile apart, were the same locations sampled during 1976 and contour lines were drawn as described by Prouse and Hargrave (1977).

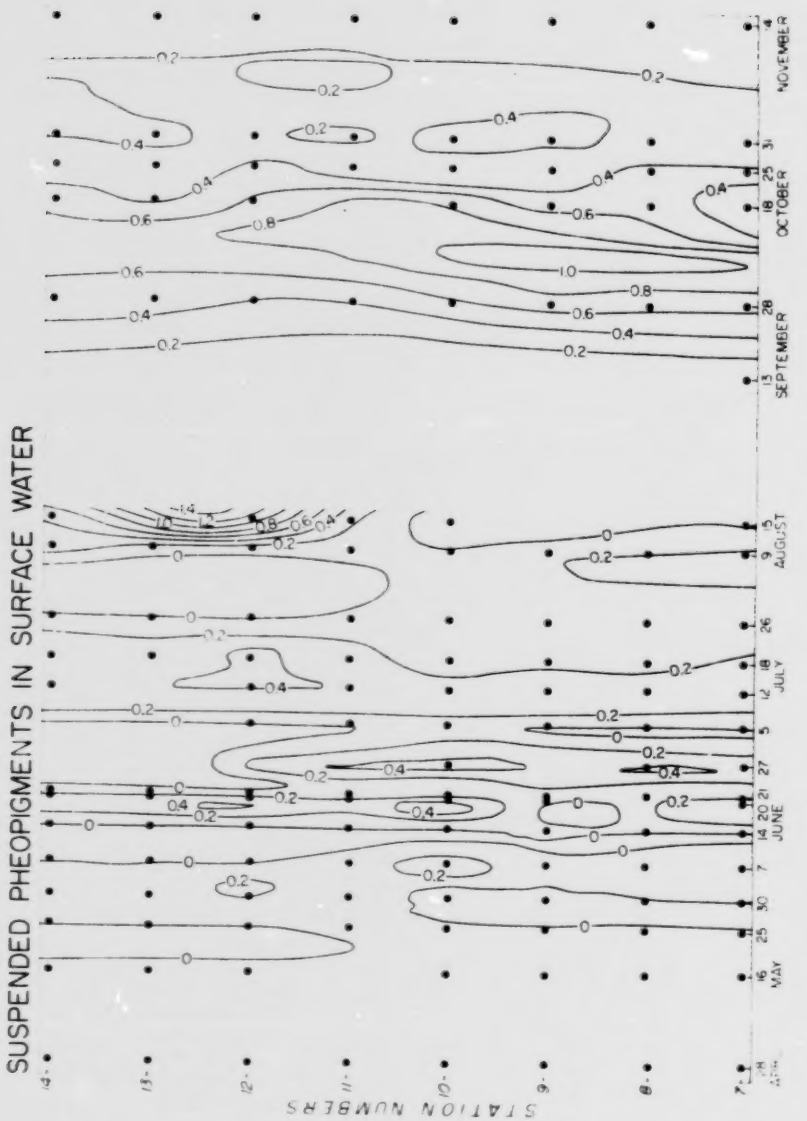

Fig. 17. Concentrations of pheopigments in surface water sampled along the transect as described in Fig. 16.

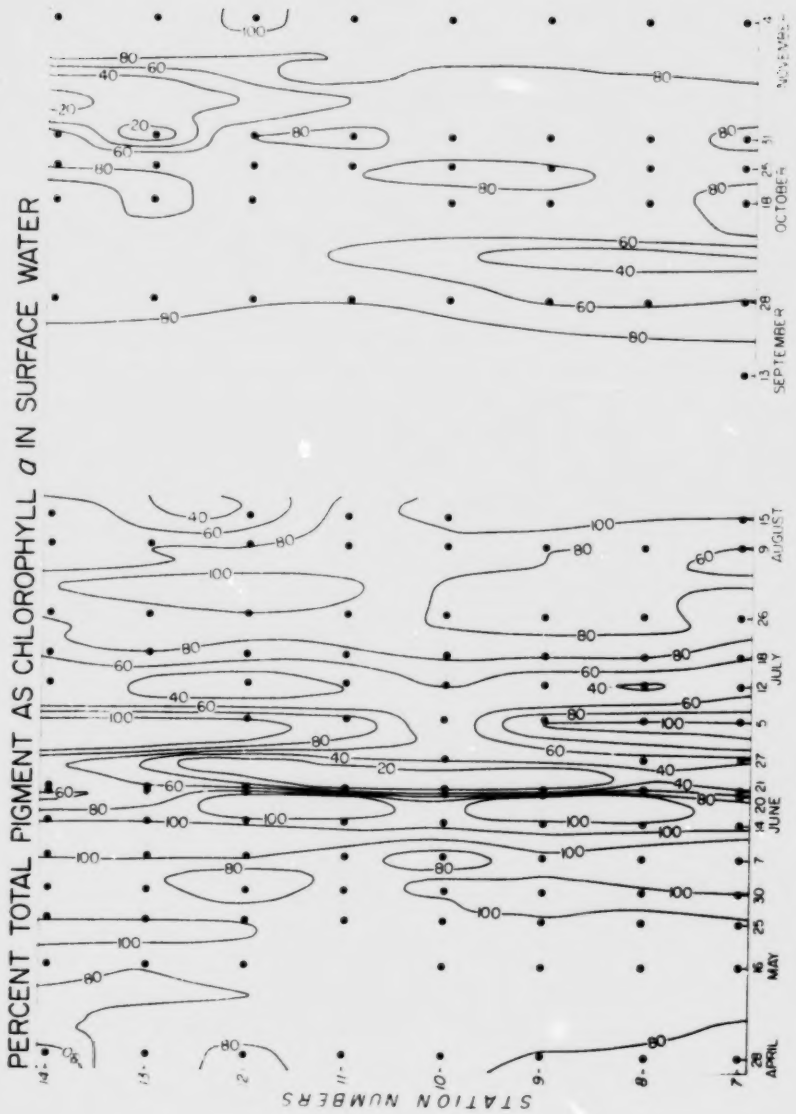

Fig. 18. Chlorophyll a concentrations, expressed as a percentage of total chlorophyll a and pheopigment concentrations in surface water sampled along the transect as described in Fig. 16.

4. SEASONAL ABUNDANCE, BIOMASS, LIPID CONTENT, SIZE COMPOSITION, AND MEAN BIOMASS OF PLANKTON

(G. Harding, P. Vass, and S. Pearre)

Relationship between Wet and Dry Weight of Plankton

The seasonal wet and corresponding dry weight per cubic metre of each size fraction are recorded in Tables 9 and 10, respectively. It is desirable to have a consistent nondestructive measure of plankton biomass which allows further analysis of the sample for taxonomic or other descriptive purpose. The information gained from the present study was examined to determine whether consistent measurements of wet weight can be obtained with the use of a vibrating screen device (described in Samping and Analytical Methods). Wet weight per sample was plotted against dry weight per sample (Fig. 19) and $\log_{10}$ transformed data fitted with a linear function. Both variates possess inherent or biological variability and are also subject to errors of measurement so the geometric mean estimate of the functional regression was used following

Ricker (1973). A close relationship exists between wet (W_w) and dry weight (W_d) per sample:

$$\log W_w = 0.901 + 0.991 \log W_d,$$

$$r = 0.95, N = 121 \qquad (1)$$

with the 95% confidence interval of the slope being ±0.056. In other words, dry weight can be expressed as 13.5 to 15% of wet weight. This improves upon the findings of Weibe et al. (1975) who report a slope of 0.946 ±0.062. Weibe et al. (1975) took care to blot their plankton samples for consistent measurement of wet weight so it is not obvious why our data should have a closer fit to a straight line.

Weights of each sample were standardized by volume of sea water filtered (m^{-3}) for further comparison with the results of Weibe et al. (1975). The 66 to 125 µm, >2035 µm and the total size fraction data had proportionately more water, presumably interstitial, at higher standing stocks (see Table 11). The relationship in equation 1 is altered by this standardization to volume filtered (m^{-3})

Table 9. Wet weight of plankton, St. Georges Bay, 1977 (mg wet wt m^{-3}).

	Plankton Size (m)								
	20		57	224		460 m net			
	25-66	66-125	66-125	125-250	250-509	509-1028	1028-2035	>2035 µm	Total
April 26	203.5	295.9	-	955.4	113.8	15.5	7.9	31.4	1623.4
May 16	162.5	224.0	-	188.4	251.4	22.7	9.2	16.3	874.5
May 24	57.2	-	49.9	129.5	455.5	68.1	6.6	34.4	801.2
June 8	43.0	42.5	64.2	83.7	174.8	48.9	43.1	4.2	461.9
June 21	66.6	117.0	119.5	158.5	428.7	74.9	64.5	5.7	918.4
July 7	105.2	111.8	111.7	322.6	400.9	42.5	12.2	21.8	1016.9
July 21	303.3	401.9	191.6	209.6	130.7	110.7	5.6	1.9	953.4
August 4	34.8	33.2	52.4	164.2	158.5	77.9	11.9	0.2	499.9
August 18	141.3	42.6	43.3	101.9	121.6	23.9	2.3	5.7	440.0
September 8	114.6	31.1	36.7	82.6	214.3	33.4	5.5	0.6	487.7
September 27	48.9	59.2	48.6	224.7	125.1	25.9	6.8	17.7	497.7
October 6	170.6	191.6	130.1	521.7	146.3	47.9	4.2	8.1	1028.9
October 25	49.5	35.1	34.2	49.7	764.0	100.0	7.7	7.9	1013.0
November 3	70.3	39.1	53.4	136.2	159.2	38.2	7.9	16.2	481.4
November 15	35.6	44.6	49.2	105.3	252.6	84.1	165.8	26.8	756.8
	32.8	46.6							
	73.0	78.7							
Mean	107.1	119.2	75.7	228.9	259.8	54.3	24.0	13.2	
± s.d.	±76.8	±116.6	±47.5	±232.6	±181.0	±29.8	±42.7	±11.2	

because individual data points are differentially located nearer to or farther from the origin (compare Fig. 19 and Fig. 20). In the new plot (Fig. 20) points farthest out from the origin represent times of high plankton abundance and may contain very different species assemblages from those at times of plankton scarcity (as discussed below). Further insight is gained by plotting the ratio of wet weight to dry weight against sample size (Fig. 21). A great deal of variability exists in this ratio at sample weights below 3 g dry weight, particularly the smallest two size fractions. This shows that the interstitial water in the smaller size fractions is consistently more difficult to remove, presumably due to the higher surface tension created by the greater surface area of organisms per unit weight. In conclusion, wet weight is not a reliable measure of biomass in the present collections if the sample weight is less than 3 g dry weight.

24 Total Lipid Content in Various Size Classes of Plankton

A clear relationship between the amount of lipid in a plankton size category and either wet or dry weight was not observed even though there were large seasonal variations in the lipid content. Highest lipid values, both as total lipid per cubic metre (Table 12) and lipid per unit dry weight (Table 13), occurred between April 26 and June 21, thereafter the lipid content decreased to approximately 50% of the spring values. The size classes responsible for these high spring lipid values may change between sampling dates; however, most size fractions have the greatest amount of lipid within the first five sampling dates (Table 12). The 25 to 66 µm fraction, mainly phytoplankton (see Table 14), had the highest lipid per cubic metre on April 26, May 16, July 7, November 3 and 15 but the highest concentration per unit dry weight occurred on July 7 and in November. The overall seasonal change in lipid content of the plankton coincides with a seasonal shift from a spring, cold-water, Temora-Pseudocalanus-Calanus dominated community to a warmer-water,

Table 10. Dry weight of plankton, St. Georges Bay, 1977 (mg dry wt m^{-3}).

		Plankton Size (m)								
		20		57		224		460 µm net		
	S.T.	25-66	66-125	66-125	125-250	250-509	509-1028	1028-2035	>2035 µm	Total
April 26	4.3°C	13.8	18.1	-	105.7	21.5	3.1	1.1	3.2	166.5
May 16	4.3	12.5	14.1	-	35.3	30.3	4.1	1.0	1.8	99.1
May 24	11.3	6.0	-	5.1	22.7	77.7	11.5	1.0	2.9	126.9
June 8	8.5	5.5	4.4	8.5	11.6	24.6	8.1	6.1	0.7	65.1
June 21	7.5	7.6	13.0	15.8	28.5	58.8	10.6	9.9	1.3	132.5
July 7	15.0	15.8	14.0	13.4	47.4	49.9	5.8	1.8	2.5	136.6
July 21	18.8	14.4	19.4	10.7	15.2	16.9	13.1	0.8	0.3	71.4
August 4	21.5	3.2	2.9	4.8	15.6	21.8	9.4	1.4	0.1	59.3
August 18	19.8	12.8	4.2	4.8	11.2	18.4	3.4	0.6	0.9	52.1
September 8	19.0	8.7	2.6	2.9	9.9	30.7	4.3	0.4	0.3	57.2
September 27	14.8	7.5	4.1	3.7	26.3	17.4	4.9	1.8	2.9	64.5
October 6	14.5	16.0	11.7	9.1	32.1	18.0	7.0	0.8	1.1	84.1
October 25	11.3	10.8	3.3	5.2	7.8	76.8	11.8	1.4	1.6	115.4
November 3	10.6	13.6	4.6	6.1	19.0	21.5	6.2	1.3	1.8	69.5
November 15	9.5	5.1	4.3	4.6	12.5	37.8	15.1	29.1	2.8	107.0
		4.4	4.7							
		10.2	8.4							
Mean		10.2	8.6	7.3	26.7	34.8	7.8	3.9	1.6	
± s.d.		±4.2	±6.1	±3.9	±24.5	±21.1	±3.8	±7.4	±1.0	

Table 11. Relation between wet weight (W_w) and dry weight (W_d) of plankton per cubic metre; equations fitted by linear regression analysis after logarithmic transformation.

	Standard Regression Analysis			Geometric Mean Regression Analysis	
Size Fraction (m)	Equation	r	N	Equation	Regression Coefficient ± 95% Confidence Interval
25-66	$W_w = 6.67\ W_d^{1.13}$	0.82*	17	$W_w = 3.88\ W_d^{1.38}$	1.38 ±0.43
66-125	$W_w = 9.22\ W_d^{1.08}$	0.92*	29	$W_w = 11.3\ W_d^{1.18}$	1.18 ±0.13
125-250	$W_w = 8.35\ W_d^{0.99}$	0.90*	15	$W_w = 6.12\ W_d^{1.09}$	1.09 ±0.28
250-509	$W_w = 6.18\ W_d^{1.04}$	0.96*	15	$W_w = 5.49\ W_d^{1.08}$	1.08 ±0.18
509-1028	$W_w = 5.22\ W_d^{1.12}$	0.96*	15	$W_w = 4.78\ W_d^{1.16}$	1.16 ±0.19
1028-2035	$W_w = 6.69\ W_d^{0.94}$	0.95*	15	$W_w = 6.55\ W_d^{0.98}$	0.98 ±0.18
2035	$W_w = 5.83\ W_d^{1.42}$	0.97*	15	$W_w = 5.8\ W_d^{1.45}$	1.45 ±0.21
Total	$W_w = 6.79\ W_d^{1.08}$	0.96*	121	$W_w = 6.31\ W_d^{1.12}$	1.12 ±0.06

* Significant at the 1% level.

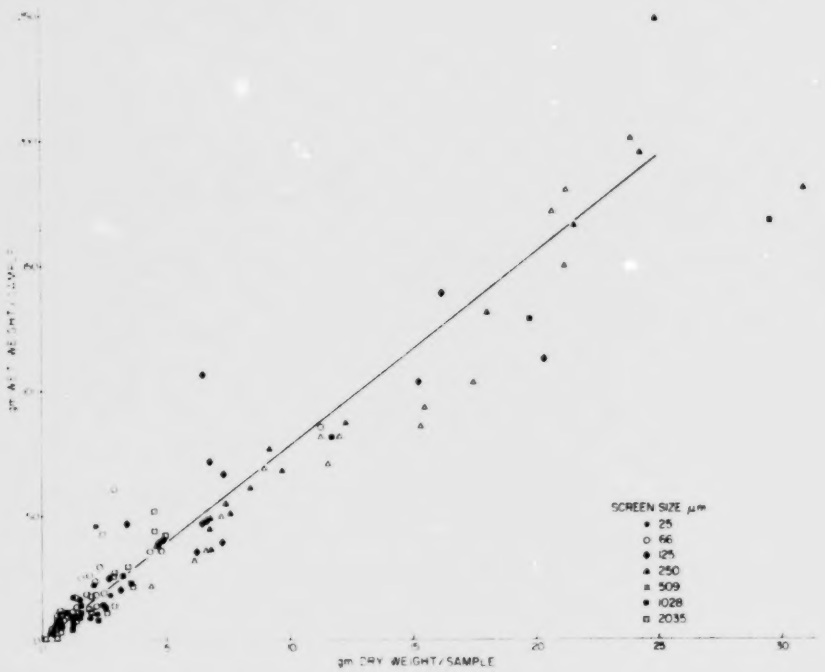

Fig. 19. Relationship between dry weight (W_d) and wet weight (W_w) of plankton in each sample collected at the central station in St. Georges Bay.

$$W_w = 7.96\ W_d^{0.991 \pm 0.056} \qquad r = 0.95,\ n = 121$$

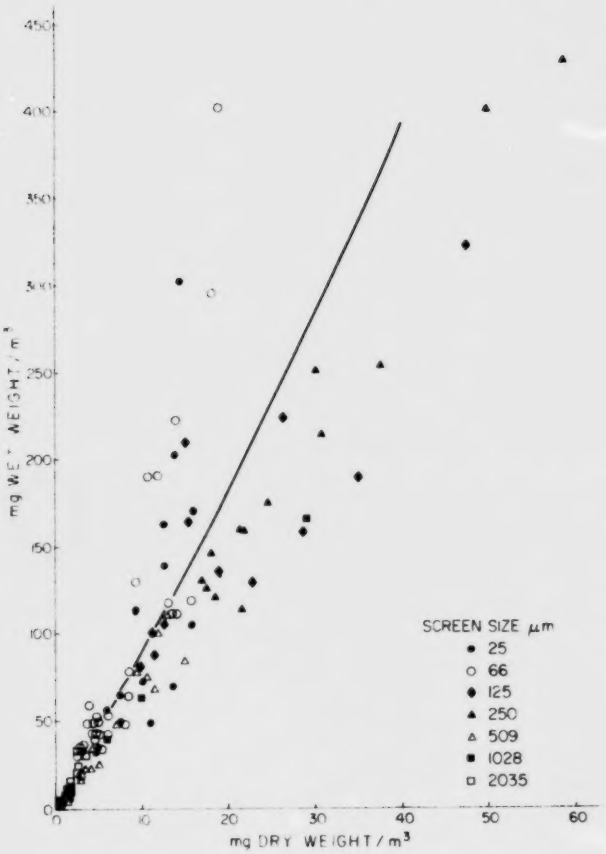

Fig. 20. Relationship between dry weight (W_d) and wet weight (W_w) of plankton collected at the central station in St. Georges Bay expressed per cubic metre of sea water filtered.

$$W_w = 6.31\ W_d^{1.12 \pm 0.06} \qquad r = 0.96,\ n = 121$$

Centropages-Tortanus-Acartia community (Table 14, Fig. 22).

The two smallest size classes have the lowest lipid content (Table 13) which is to be expected because they are mainly dinoflagellates and diatoms (Table 14). Parsons et al. (1961) lists lipid content of 1.8 to 6.9% dry weight for four species of diatoms and 15 to 18% for two species of dinoflagellates during exponential growth. Similarly, Lee et al. (1971) give lipid values of 8.6 to 13.2% dry weight for three species of marine diatoms. The 66 to 125 m fraction contains proportionately more zooplankton than phytoplankton (Table 14) which accounts for the higher lipid content in this class. The 250 to 509 m size fraction, over our sampling season, accounts for most of the lipid in the water column (Table 12) yet the lipid per unit weight of plankton increases with size up to the 1028 to 2035 m class (Table 13). The 250 to 509 and 509 to 1028 μm size classes have 5.4 to 12.8% lipid on a dry weight basis in the spring when the fractions are dominated by Temora longicornis (see Fig. 22 and Table 14). From July 7 to November 15 these same fractions contain increasingly more Centropages hamatus, Tortanus discaudatus and Acartia hudsonica and the lipid content lowers to between 2.2 and 8.9% dry weight. Conover and Corner (1968) found lipid content of 14% dry weight for the closely related Centropages typicus in slope water off Maine. Ackman et al. (1974) reported lipid content which converts to approximately 9% dry weight, for a plankton sample dominated by Centropages typicus collected off Halifax Harbour, Nova Scotia. Nakai (1955) also found low lipid values of 5.8% dry weight for Acartia clausi collected off Japan.

Surprisingly, the highest lipid values, 12.2 to 23% dry weight, were not found during the spring in the 1028 to >2035 μm size fraction when Calanus finmarchicus and stage IV Calanus hyperboreus were numerous (Fig. 22). Conover and Corner (1968) found a considerably broader range of lipid values, 20 to <50% dry weight, for adult female and stage V Calanus finmarchicus and 15 to 50% lipid for Calanus hyperboreus from waters of the Gulf of Maine. However, lower values of 15 to 30% lipid occurred in both species during the spring months of March and April which agrees with our measurements for the April to June period in St. Georges Bay. The >2035 μm size fraction contributed the least lipid to the total water column which is perhaps due to the variable presence of organisms such as jellyfish, ctenophores and chaetognaths which are known to have a low lipid content (Lee, 1974).

Seasonal Abundance of Plankton

The biomass of plankton within the entire 25 to >2035 μm size interval sampled was

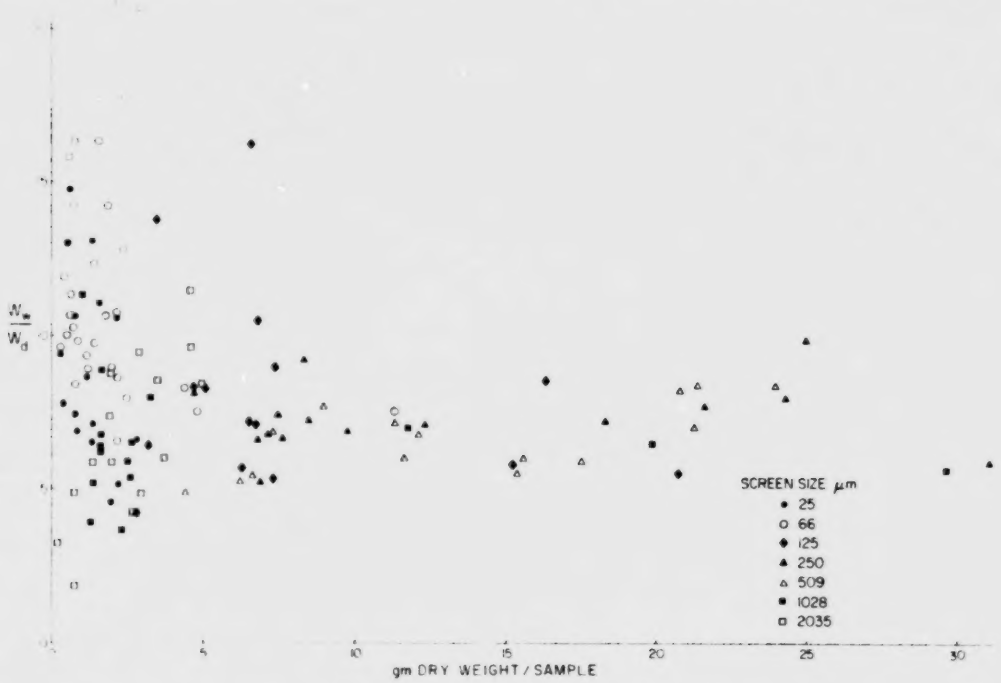

Fig. 21. Plot of sample size (W_d) against the ratio of wet weight to dry weight.

Table 12. Lipid weight of plankton, St. Georges Bay, 1977 (g lipid m^{-3}).

	Plankton Size (m)								
	20		57	224	460 m net				
	25-66	66-125	66-125	125-250	250-509	509-1028	1028-2035	>2035 µm	Total
April 26	103	267	-	3305	1750	255	236	124	6040
May 16	124	161	-	432	1827	391	140	8	3083
May 24	80	-	389	873	6320	661	122	114	8559
June 8	40	138	581	863	2105	1042	1409	23	5620
June 21	66	758	809	1802	3226	767	1918	29	8566
July 7	304	637	321	392	1776	239	231	81	3660
July 21	18	66	19	94	1211	966	44	6	2405
August 4	27	51	236	555	913	736	16	4	2302
August 18	22	11	9	131	580	162	4	2	912
September 8	45	9	78	609	2734	222	10	1	3630
September 27	74	29	122	1439	776	215	33	26	2592
October 6	85	53	32	395	402	239	48	20	1242
October 25	35	85	40	258	1864	294	91	105	2732
November 3	306	87	54	883	1321	359	100	83	3139
November 15	112	119	31	222	1904	388	455	33	3233
	86	159							
	94	68							
Mean	96	176	209	816	1913	462	323	43	

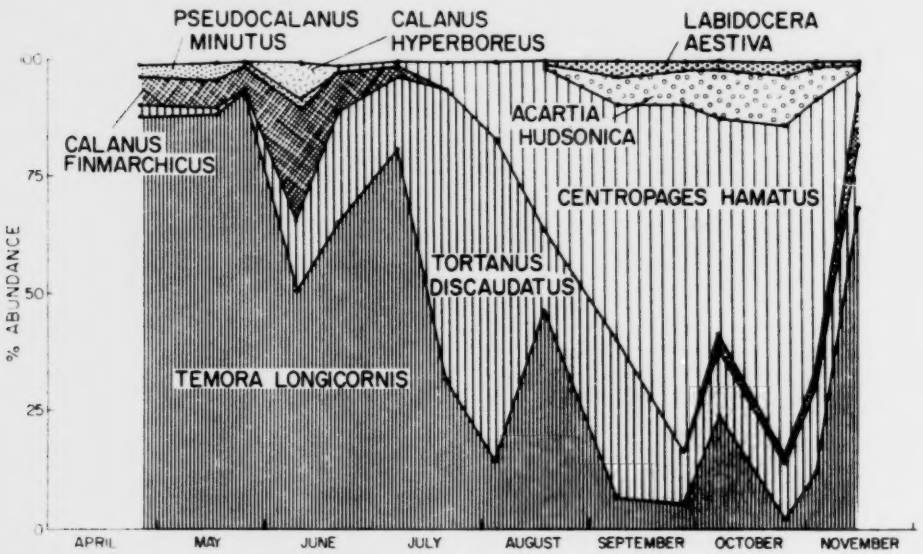

Fig. 22. Seasonal abundance of adult copepods per cubic metre in St. Georges Bay during 1977.

Table 13. Lipid weight per dry weight, St. Georges Bay, 1977 (g mg^{-1}).

	Plankton size (µm)								
	20		57		224	460 m net			
	25-66	66-125	66-125	125-250	250-509	509-1028	1028-2035	>2035 µm	Mean
April 26	7.4	14.7	-	31.2	81.3	82.2	214.5	38.7	67.1
May 16	9.9	11.4	-	12.2	60.2	95.3	140.0	4.4	47.6
May 24	13.3	-	76.2	38.4	81.3	57.4	122.0	39.3	61.1
June 8	7.2	31.3	68.3	74.3	85.5	128.6	230.9	32.8	84.3
June 21	8.6	58.3	51.2	63.2	54.8	72.3	193.7	22.3	67.6
July 7	19.2	45.5	23.9	8.2	35.5	41.2	128.3	32.4	44.3
July 21	1.2	3.4	1.7	6.1	71.6	73.7	55.0	20.0	33.0
August 4	8.4	17.5	49.1	35.5	41.8	78.2	11.4	40.0	33.2
August 18	1.7	2.6	1.8	11.6	31.5	47.6	6.6	2.2	14.8
September 8	5.1	3.4	26.8	61.5	89.0	51.6	25.0	3.3	34.1
September 27	9.8	7.0	32.9	54.7	44.5	43.8	18.3	8.9	26.7
October 6	5.3	4.5	3.5	12.3	22.3	34.1	60.0	18.1	22.3
October 25	3.2	25.7	7.6	33.0	24.2	24.9	65.0	65.6	34.5
November 3	22.5	18.9	8.8	46.4	61.4	57.9	76.9	46.1	47.1
November 15	21.9	27.6	6.7	17.7	50.3	25.6	15.6	11.7	24.3
	19.5	33.8							
	9.2	8.0							
Mean	9.6	19.4	27.5	33.7	55.6	60.9	90.8	25.7	

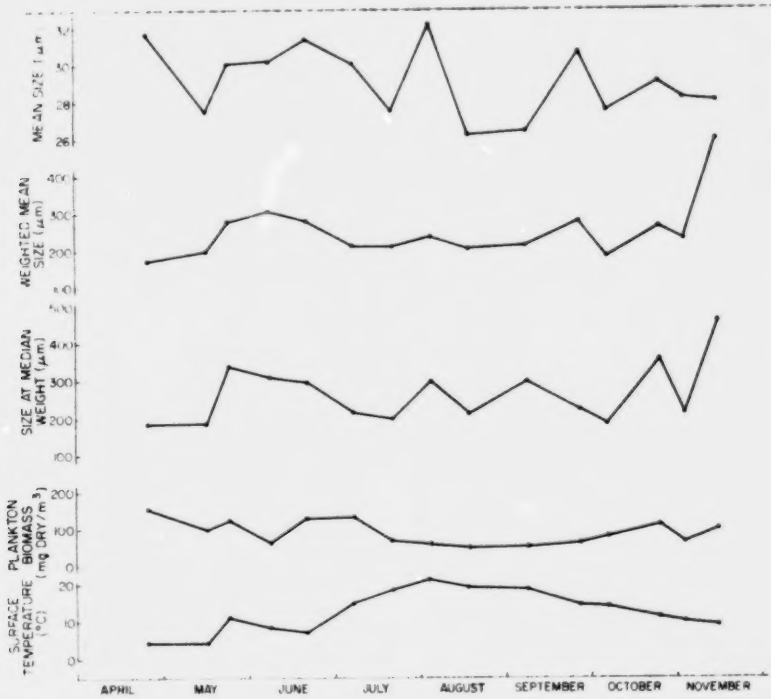

Fig. 23. Mean size, weighted mean size, size of median weight and plankton biomass in St. Georges Bay during 1977.

Table 14. Species composition of size fractions of plankton in St. Georges Bay (April-November 1977).

Screen Size	Dominant Form(s)	Abundant Form(s)	Present - Not Abundant
25-66 µm	Dinophysis sp. (Apr.26-Nov.15)	Thalassiothrix sp. (Apr.26-May 16) Rhizosolenia sp. (July 21) tintinids (Oct.6-Oct.25)	Exuviella, Phalacroma Peridinium, Prorocentrum, Skeletonema, Gyrosigma, Hantzschia, Chaetoceros pennate diatoms, Pterosperma, silicoflagellates, tintinids.
66-125 µm	Copepod naulpii and eggs (Apr.26-Nov.15)	Rhizosolenia (May 16, July 21) tintinids (Apr.26, Oct. 6) bivalve larvae (May 24, June 21, Sept. 27) Ceratium fusus (Sept. 8) Chaetoceros (Nov. 15)	bivalve larvae, 180 µm eggs, tintinids, pennate diatoms, Limacina, centric diatoms, Ceratium longipes.
125-250 µm	Copepodids of Oithona (Apr.26-Nov.15)	Copopodids and nauplii of Oithona and naupliar and copopodid stages I and II of Temora, Pseudocalanus, Centropages, Tortanus, Acartia (Apr.26-Nov.15) bivalve larvae (Apr.26-Nov. 15) tintinids (Apr.26) Rhizosolenia (May 16, July 21) Centric diatoms (~300 µm) (Oct. 25-Nov. 15) Ceratium fusus (Aug. 18-Sept. 8) Limacina retroversa (Oct. 6-Nov. 3)	tintinids, centric diatoms, Tortanus eggs, Ceratium longipes
250-509 µm	late Copepodids of Temora, Centropages, Tortanus, Pseudocalanus, Acartia (Apr. 26-Nov. 15)	Limacina retroversa (Oct. 6-Nov. 15) centric diatoms (~300 µm) (Oct. 6-Nov. 3)	Cyprid and bivalve larvae, Evadne, Podon, and Limacina
509-1028 µm	adult copepodids of Temora, Centropages Tortanus (Apr.26-Nov.15)	Limacina retroversa (Oct. 6-Nov. 15)	Crab zoea and megalops, Limacina, juvenile euphausiids, cyprid and bivalve larvae, fish eggs, juvenile decapods, amphipods, late copepodids of Calanus and Bradyidius.

Table 14 continued:

1028-2035 µm	amphipods (Apr.26, May 16, Aug.18-Oct. 6, Nov. 3) fish larvae (Apr.26, May 16, July 7,21, Oct. 25)	mackerel eggs (June 8, June 21) euphausiids (June 21, Aug. 4, Oct. 25) adult Calanus (Apr. 26, June 21) Crangon (Sept.8, Nov.3) Limacina (Nov. 15)	amphipods, cumaceans, euphausiids, decapods, fish larvae, crab zoea, and megalops, chaetognaths Limacina, Calanus.
>2035 µm	decapods and euphausiids	Thysanöessa (Apr. 26, Aug.18, Oct.25) Pandalus (Apr.26-Aug.4) Crangon (July 21, Sept.8-Nov. 15) amphipods (Aug. 4) fish larvea (Aug. 18, Oct.25-Nov.15) Sagitta (May 24) ctenophores (Apr. 26)	euphausiids, decapods amphipods, cumaceans, ctenophores, chaetognaths, isopods, fish larvae, Calanus, Clione.

highest in April, 166.5 mg dry weight m^{-3}, and decreased to less than 60 mg m^{-3} in August and September (Table 10, Fig. 23). There are slight biomass maxima between June 21 to July 7, on October 25 and November 15. Since neither replicate tows were taken nor additional stations sampled, the low biomass value on June 8 may be spurious. This would indicate that a stepped decrease in biomass occurred throughout the summer to minimum values during August and September. This minimum is not attributable to any single size fraction decreasing markedly out of proportion to any other (Fig. 24).

The descriptive literature available on the distribution of plankton biomass, both spatial and temporal, is copious but by convention has been reported as biomass m^{-3} or m^{-2} for a specific net. These results are therefore too limited to compare with the present range of plankton sizes recorded for St. Georges Bay. Sheldon and Parsons (1967), using a Coulter counter, were the first to present a size-frequency spectrum for planktonic organisms of 3 to 1024 µm spherical equivalents. Their June values for plankton collected in Saanich Inlet, B.C., range from 0.03 to ~0.2 mg wet wt L^{-1}, assuming a density of 1.0. Sheldon et al. (1972) described north-south patterns of particle spectra of 0.63 to 100 µm for the Atlantic, Southern and Pacific Oceans. They also illustrate two size frequency spectra of 1 µm to 4 mm for the South Atlantic; 0.005 to 0.02 mg wet wt L^{-1} at 10°S and 0.015 to 0.13 mg wet wt L^{-1} at 35°S. Sheldon et al. (1977) reported particle concentrations during February of up to ~0.025 mg wet wt L^{-1} for an interrupted size interval of 0.5 to 80 µm and 250 µm to 2 cm in the Sargasso Sea. The seasonal plankton spectra presented here (Table 9) for the temporate coastal waters of St. Georges Bay have consistently higher concentrations with a maximum seasonal average of 0.26 mg wet wt L^{-1} in the 250 to 509 µm size class.

The seasonal distribution of biomass of each size fraction expressed as dry weight per litre (since dry weight is a more reliable indicator of biomass, see above) is plotted in Fig. 24. The 125 to 250 and 250 to 509 µm fractions on average, had the highest biomass throughout the sampling season. The 125 to 250 and 250 to 509 µm classes had maximum concentrations of 0.11 mg dry wt. L^{-1} on April 26 and 0.07 mg dry wt. L^{-1} on May 24 and October 25, respectively. Superimposed on this general pattern are distinct 'blooms' of smaller particles. On April 26, the 25 to 66 µm fraction was comprised of a bloom of Dinophysis and Thalassiothrix while the 66 to 125 µm fraction was Thalassiothrix and tintinids. This pulse apparently continued until May 16 but by this time the 66 to 125 µm fraction had changed to Rhizosolenia. The July 7 pulse was

Table 15a. Copepods per cubic meter collected with a 1 m diameter, 460 µm mesh net towed obliquely to and from the bottom (~34 m) at the central station in St. Georges Bay during 1977.

	Apr.26	May 17	May 25	Jun.9	Jun.21	Jul.7	Jul.21
Sample Volume	1165 mL	1575 mL	1640 mL	1455 mL	1500 mL	1645 mL	1695 mL
Subsamples	9x5 mL	4x5 mL	3x5 mL	6x2 mL	3x5 mL	6x2 mL	3x2 mL
Sea Water Filtered	986 m^3	986 m^3	715 m^3	980 m^3	1361 m^3	1127 m^3	1531 m^3
1. Metridia longa	0.1				0.07		
2. Eurytemora herdmani		0.07					
3. Bradyidius similis	0.05	0.08	0.46				
4. Scolecithricella minor				0.12			
5. Acartia longiremis	0.08	0.32	0.15	0.12	0.07		
6. Pseudocalanus minutus	1.13	2.48	1.38	2.97	1.10	0.37	0.55
7. Calanus hyperboreus				12.25	1.25		
8. Calanus finmarchicus	2.73	3.83	7.04	38.99	18.95	3.65	0.74
9. Temora longicornis	39.43	57.73	142.23	81.19	141.56	131.06	96.31
10. Tortanus discaudatus	0.87	0.72	0.61	23.14	51.13	25.43	180.62
11. Centropages hamatus	0.26			0.99	2.35	1.70	17.71
12. Labidocera aestiva							0.37
13. Acartia hudsonica							
14. Centropages typicus							
15. Metridia lucens							

due to Dinophysis in the 25 to 66 μm and copepod nauplii in the 66 to 125 m size. Both size fractions were dominated by Rhizosolenia by July 21. The small bloom on August 18 consisted of Dinophysis again whereas the same peak in September was caused by an unidentified green slime. The fall bloom starting in October was approximately half tintinids and half dinoflagelletes (Dinophysis, Exuviella and Phalacroma).

The species composition of the middle-sized fractions changed quite abruptly in July (Table 15) but the biomass proportions between size classs are not noticeably altered with the exception of July 21 (Fig. 24). Mackerel eggs appeared as a large pulse on June 8 and 21 on the 1028 μm screen. Limacina retroversa suddenly appeared on the same screen size in large numbers on November 15 following the complete mixing of the water column. The largest size fraction, >2035 μm, almost disappeared during the warmest period from July 21 to September 8. This is largely due to the absence of a Pandalus shrimp. Whether Pandalus were consumed by predators during this period, migrated out of the bay, or simply ceased or altered the timing of their vertical movements off the bottom and therefore were not caught by our nets, is not known.

Hypothesis of Equal Biomass over Logarithmic Size Intervals

Sheldon et al. (1972, 1977) have hypothesized that equal biomass exists between logarithmic size intervals in the pelagic food web. Our data support their observations, within an order of magnitude for any particular sampling date, for plankton sizes up to 509 m, but thereafter the pattern is broken (Fig. 24). This discrepancy may be explained by an oversight in our sampling scheme whereby the smaller size fractions were collected from the top 5 to 10 m and the fractions larger than 509 m were collected throughout the entire water column. Smaller forms tend to be found near the surface while large zooplankters migrate daily throughout the water column. Although it was a logical way to collect large numbers of organisms (the design was originally planned to obtain samples for organochlorine analysis), it results in spuriously high biomass per cubic metre for small size fractions when compared to the integrated values for the larger organisms over the entire water column.

Table 15b. Copepods per cubic metre collected in St. Georges Bay with a 1 m diameter, 460 m mesh net towed obliquely to and from the bottom (~34 m).

	Aug. 4	Aug.18	Sep. 8	Sep.27	Oct. 6	Oct.25	Nov. 3	Nov.15
Sample Volume	1690 mL	1590 mL	1410 mL	1555 mL	1500 mL	1500 mL	1555 mL	1555 mL
Subsamples	3x2 mL	6x2 mL	6x2 mL	3x2 mL	6x2 mL	3x2 mL	6x2 mL	3x10 mL 6x15 mL
Sea Water Filtered	938 m^3	1068 m^3	1138 m^3	868 m^3	942 m^3	1054 m^3	1086 m^3	549 m^3
1. Metridia longa								
2. Eurytemora herdmani								
3. Bradyidius similis								
4. Scolecithricella minor								
5. Acartia longiremis								
6. Pseudocalanus minutus	0.30						0.36	
7. Calanus hyperboreus					0.13		0.12	
8. Calanus finmarchicus	0.30	0.50	0.21	1.19	7.30	4.27	6.68	2.22
9. Temora longicornis	38.42	53.72	12.81	18.81	55.99	8.06	25.42	14.05
10. Tortanus discaudatus	181.01	20.10	62.68	35.53	32.11	42.20	36.52	2.69
11. Centropages hamatus	44.13	39.82	92.94	243.02	104.81	247.53	114.92	1.11
12. Labidocera aestiva		0.62	6.30	5.67	4.38	10.67	1.67	0.05
13. Acartia hudsonica		0.50	11.26	23.88	23.75	37.94	14.20	0.17
14. Centropages typicus								0.09
15. Metridia lucens								0.04

Seasonal Plankton Size

Three statistics are used to describe the size of plankton within the 25 to >2035 μm interval. Mean size, $\Sigma N_i S_i / \Sigma N_i$, is calculated by assuming spherical organisms with an equivalent diameter to the pore size of the retaining screen and a physical density of 1 g cm^{-3}. N_i is the calculated numerical abundance from wet weight and S_i the corresponding screen size. The weighted mean size is estimated from $\Sigma W_i S_i / \Sigma W_i$, where W_i is the dry weight of plankton retained on the i^{th} screen. Finally the size at the median weight of plankton within the 25 to >2035 μm interval was estimated from curves of log-size against cumulative dry weight (W. Silvert, pers. comm.).

As expected, the mean size statistic overemphasizes the small particle abundance and can be used to illustrate the phytoplankton and tintinid blooms of May 16, July 21, August 18, September 8, and October 6 (Fig. 23). Conversely, the weighted mean size is very sensitive to biomass in the largest size fractions. This is best seen on November 15 when the pteropod swarm appeared in the 1028 to >2035 μm fraction (Fig. 23 and 24). Perhaps the best measure of central tendency for such a broad range is the plankton size at the median weight since it is less sensitive to the extreme values (Fig. 23). Again the low values coincide with phytoplankton and tintinid blooms but the high values result from high biomass in the 250 to 509 μm fraction. Larger organisms appear to predominate from May 24 to June 21, August 4, September 8, October 25, and November 15 (Fig. 24). More stations with a closer spacing of sampling dates are needed before a clear seasonal pattern of plankton size can be obtained.

Plankton size was determined in a previous study in St. Georges Bay for comparison with mackerel egg and larval size. Ware (1977) calculated the weighted mean size of the catch from a ½ m, 80 μm mesh net fractionated into size classes of plankton between 80 and 1050 μm. His data show a clear decrease in mean plankton size towards the warmest months, with minimum values from July to September, followed by an increase in size during November and December. The apparent conflict between our data sets is resolved when it is realized that the weighted mean size statistic emphasizes the larger size fractions and that Ware's experimental design placed more fractions in the larger size range. Ware was observing a very striking shift from a cold-water, Calanus-Temora-Pseudocalanus community to the warm-water, Centropages-Tortanus-Acartia community (see Fig. 22).

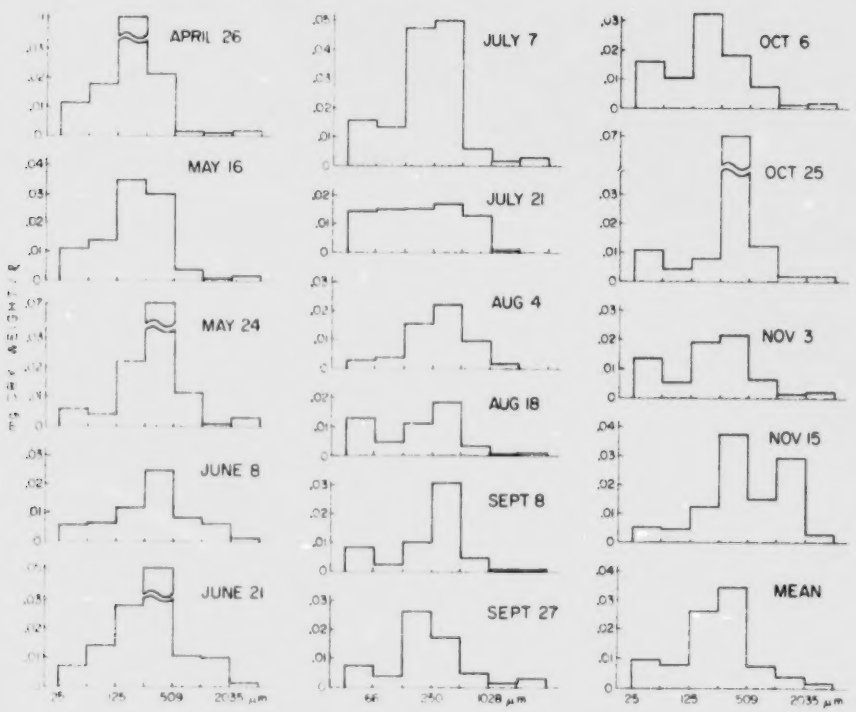

Fig. 24. Seasonal size-frequency spectra of plankton at the central station in St. Georges Bay during 1977.

5. SEDIMENTATION
(B. Hargrave and N. Prouse)

Quantitative measures of material deposited in cylindrical traps suspended at various depths at the two stations in St. Georges Bay are summarized in Appendix IV.

Coefficients of variation ($\sigma/\bar{x}$) for dry weight settled in four traps suspended at one depth varied beween 0.02 and 1.20 with no consistent variation over depth or time. The average value throughout the six months of observation (0.11) was similar to that derived for previous measures of sedimentation in St. Georges Bay and Bedford Basin (Prouse and Hargrave, 1977; Hargrave et al., 1976). Weighing errors involved in determinations of dry weight were equivalent to a coefficient value of 0.01 for the mean weight deposited in cylinders. Other sources of variation (resuspension and flushing of settled material from traps during collection, loss on retrieval and decanting before filtration, colonizaton of traps by planktonic animals) could affect the absolute weight of material collected from each cylinder. Neither large zooplankton nor small fish were ever observed in the flocculated debris settled in traps. Also traps were not retrieved during periods of rough weather. This prevented loss of particulate material which remained settled on the base of cylinders during collection.

Temporal Variation

Seasonal patterns in sedimentation of dry matter, carbon, nitrogen, chlorophyll *a* and pheopigments are illustrated by comparison of deposition rates at both stations (Fig. 25-29). All measures of deposition were low during midsummer, with similar patterns occurring 1 m and 8 m above the bottom at each station. However, traps exposed immediately above the bottom collected resuspended sediments to a greater degree than traps suspended at shallower depths (as discussed below). Thus, average monthly estimates of sedimentation were calculated for collectors suspended at 14 m (station 12) and 25 m (station 7). While deposition even at these depths may include previously sedimented material (resuspended and carried horizontally), variations in supply of particulate matter from surface waters should be more discernable. Average daily sedimentation during each collection period was calculated by assuming that deposition was continuous and cumulative. Average monthly deposition rates were calculated from daily rate estimates for each collection period (Table 16).

Periods of maximum deposition of settled material in cylinders during late May and from September to the termination of observations in mid-November occurred for all measures at both stations. Estimates of total deposition over the six month period are similar to

Fig. 25. Sedimentation of dry material in cylinders moored at depths indicated at stations 12 and 7 in St. Georges Bay during 1977.

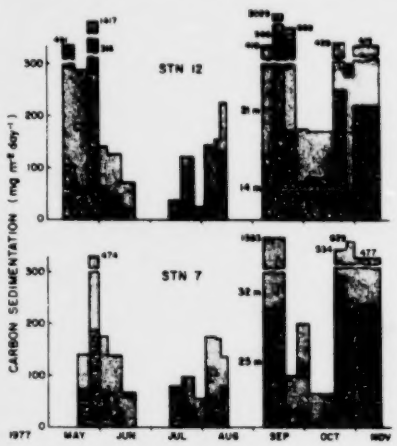

Fig. 26. Organic carbon sedimentation.

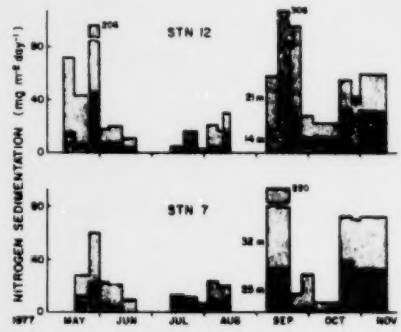

Fig. 27. Nitrogen sedimentation.

previous observations (Prouse and Hargrave, 1977) which show that sedimentation is higher in more shallow nearshore areas of St. Georges Bay. However, in that study deposition at the inshore station (station 13, 14 m depth) was three to four times higher than at station 7. Traps were suspended at 8, 11, and 13 m in contrast to measurements during the present study at 14, 18, and 21 m. Also, while there was higher deposition at the shallower depth during the six month period (average increase of 1.2 times), higher sedimentation did not always occur inshore (Table 16). Deposition during June, July, August, and November was either almost equivalent at the two stations or slightly greater offshore.

Depth Variation in Sedimentation Rates

Deposition was higher in cylinders exposed close to the sediment surface. Average daily sedimentation rates for all measurements during the six months of observations demonstrate the magnitude of the increase at both stations (Table 17). Increases of approximately 100% in all measures occurred between 18 and 21 m at station 12. At station 7, however, except for dry matter deposition (+148%), increases were less than 100%.

Considerable seasonal variation existed in sedimentation at various depths, however. This variability is reflected in the large standard deviations calculated for mean values (Table 17). Variations over time can be also illustrated by calculating the difference in sedimentation between two depths (10-24 m, station 12; 32-25 m, station 7; Fig. 30-34). Values of differential sedimentation over the 7 m depth interval were almost always positive (reflecting greater deposition with increasing depth). Seasonally, the greatest differences in sedimentation occurred in late May and mid-September (for dry matter, carbon and nitrogen) at both stations (Fig. 30-32). Differences in plant pigment sedimentation between depths were also maximum during late May. However, deposition was not always highest in traps closest to the bottom and increased values in sedimentation at the two stations did not always coincide (Fig. 33 and 34).

Calculation of linear correlation coefficients by comparison of sedimentation at all depths throughout the total collection period offers an additional way to examine depth-related differences (Table 18). Except for pheopigments, seasonal changes in all measures were closely correlated. There were also significant correlations ($p < 0.05$) for comparisons between stations, particularly between 14 and 18 m (station 12) and between 30 and 32 m (station 7). Seasonal changes in deposition at 21 m (station 12) and 25 m (station 7) showed the least coherence. Thus, while there were often large differences in sedimentation over discrete time periods at various depths, seasonal changes in deposition at all depths generally occurred at the same time. The greater similarity in sedimentation rates at 21 m (1 m above the bottom at the inshore station) with those at 32 m rather than at 25 m (1 and 8 m above the bottom at the offshore station) implies that events which alter deposition of material in traps near to the sediment are coincident at both stations. The comparisons also show that changes in sedimentation near the bottom at the inshore station are not reflected in similar changes offshore at 25 m. Temporal changes in deposition are thus correlated vertically at one station to a greater degree than they are horizontally between stations.

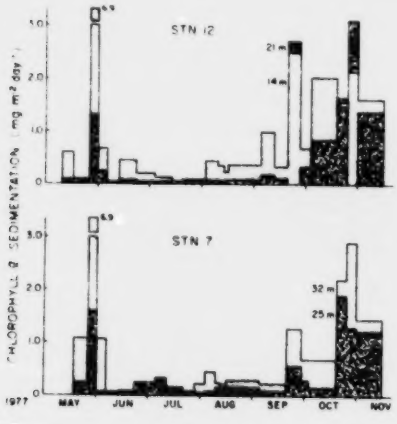

Fig. 28. Chlorophyll a sedimentation.

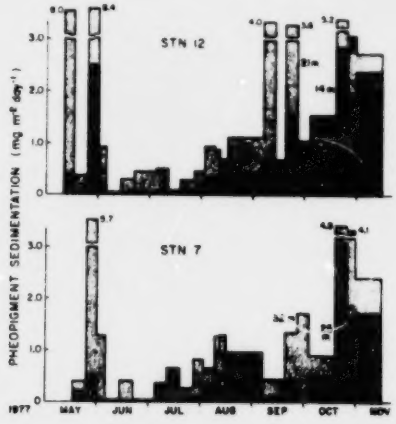

Fig. 29. Pheopigment sedimentation.

Table 16. Monthly total sedimentation in St. Georges Bay during 1977.

Month	Dry Weight g m^{-2} $month^{-1}$		Carbon g m^{-2} $month^{-1}$		Nitrogen g m^{-2} $month^{-1}$		Chlorophyll a mg m^{-2} $month^{-1}$		Pheopigments mg m^{-2} $month^{-1}$	
	Stn.12 (14 m)	Stn.7 (25 m)	Stn.12	Stn.	Stn.12	Stn.7	Stn.12	Stn.7	Stn.12	Stn.7
May (15-31)	96.9	54.0	2.5	1.9	0.35	0.26	2.4	11.8	16.4	5.2
June	30.4	47.7	1.1	1.5	0.16	0.21	1.7	2.7	1.2	0.9
July	41.0	84.5	1.1	1.6	0.13	0.23	0.7	4.1	3.0	8.6
August	48.5	50.4	1.9	1.1	0.22	0.19	3.6	3.3	12.6	23.3
September	372.7	148.2	6.5	3.9	0.96	0.55	23.1	5.9	23.2	9.6
October	313.2	183.8	5.1	3.8	0.72	0.49	44.4	24.5	66.4	42.1
November (1-14)	175.6	191.2	3.1	3.3	0.44	0.46	19.1	16.6	33.3	24.1
Total	1078.3	759.8	21.3	17.1	2.98	2.39	95.0	68.9	156.1	113.8

Table 17. Sedimentation of material in St. Georges bay, May 16-November 15, 1977 (n) = number of collection periods, mean ±1 s.d.

	Depth:	Station 7				Station 12		
		20	25	30	32	14	18	21
Dry weight g m^{-2} day^{-1}		(15)	(21)	(17)	(18)	(23)	(23)	(23)
		4.46	4.28	7.70	19.1	6.26	8.78	20.19
		±5.69	±4.85	±8.11	±26.2	±8.56	±11.34	±33.97
Carbon mg C m^{-2} day^{-1}			(18)	(15)	(18)	(20)	(20)	(20)
			99.6	164.7	294.6	135.0	194.0	391.2
			±89.9	±14.0	±36.8	±138.3	±195.0	±498.1
Nitrogen mg N m^{-2} day^{-1}			(18)	(16)	(17)	(20)	(20)	(200
			13.1	21.1	41.6	19.0	26.8	53.4
			±12.1	±18.2	±51.5	±20.3	±28.0	±75.2
Chlorophyll a µg m^{-2} day^{-1}			(21)	(17)	(18)	(23)	(23)	(23)
			394.2	640.1	1111.5	548.8	427.8	989.3
			±570.5	±697.2	±1660.9	±892.3	±671.2	±1492.5
Pheopigments µg m^{-2} day^{-1}			(21)	(17)	(18)	(23)	(23)	(22)
			612.2	1100.0	1582.0	802.8	1086.9	2027.4
			±786.0	±963.3	±1641.0	±1010.2	±1271.2	±2426.0

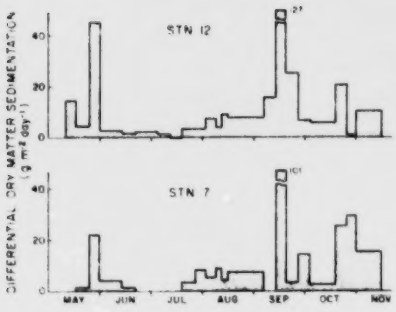

Fig. 30. Differential dry matter sedimentation (calculated as the difference in deposition between two depths shown in Fig. 25) at stations 12 and 7 in St. Georges Bay during 1977.

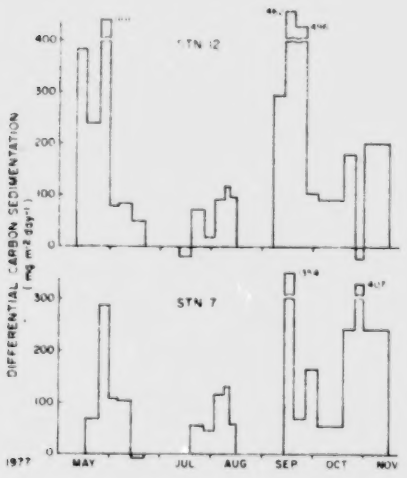

Fig. 31. Differential organic carbon sedimentation between depths shown in Fig. 26.

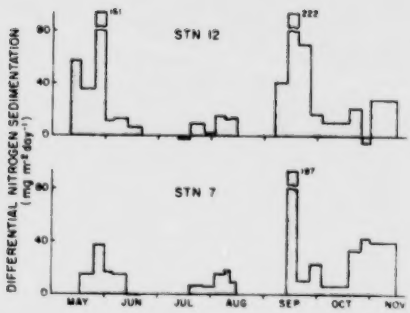

Fig. 32. Differential nitrogen sedimentation between depths shown in Fig. 27.

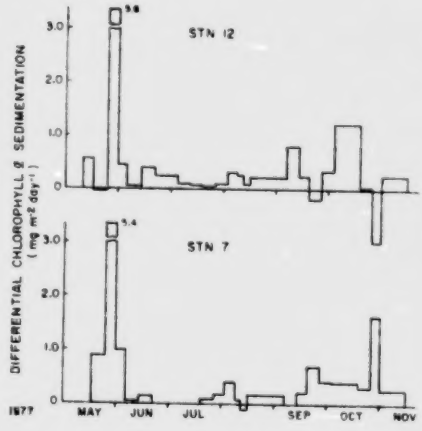

Fig. 33. Differential chlorophyll a sedimentation between depths shown in Fig. 28.

Table 18. Correlation coefficients (values of r) derived from linear regression analyses comparing sedimentation at different depths at two stations in St. Georges Bay during 1977 (n = 19).

	Depth (m)	18	21	25	30	32
Dry Weight	14	0.97	0.78	0.48	0.79	0.79
	18		0.85	0.42	0.74	0.79
	21			0.16	0.58	0.83
	25				0.70	0.40
	30					0.85
Carbon	14	0.95	0.79	0.62	0.87	0.88
	18		0.86	0.60	0.84	0.78
	21			0.30	0.54	0.70
	25				0.87	0.54
	30					0.79
Nitrogen	14	0.96	0.80	0.58	0.86	0.86
	18		0.87	0.54	0.83	0.79
	21			0.29	0.55	0.72
	25				0.84	0.56
	30					0.80
Chlorophyll	14	0.95	0.79	0.62	0.87	0.88
	18		0.86	0.60	0.84	0.78
	21			0.30	0.54	0.70
	25				0.87	0.54
	30					0.79
Pheopigments	14	0.92	0.34	0.57	0.83	0.77
	18		0.54	0.48	0.73	0.79
	21			0.25	0.34	0.83
	25				0.67	0.44
	30					0.57

Seasonal Differences in Chemical Composition of Material Settled at Various Depths

Measures of the organic and plant pigment content in material settled in collectors may be compared to consider seasonal and depth related differences which are independent of the amount of material deposited. Decomposition of material accumulated in traps could alter both the composition and total amount of organic matter remaining. Collection intervals of one week were chosen to minimize these changes.

The usual sampling procedure of determining organic and plant pigment content in particulate matter in one cylinder from each group of four was modified on October 18 and 25 when material from all traps was sampled for analysis (Appendix IV). Coefficients of variation in all measures were between 0.02 and 1.20 (Table 19). In general, variance between replicate samples was greater on October 18 than on October 25. An anomalous low value of dry weight deposited at 32 m on October 18, which produced the highest variance in dry weight, was not associated with atypical values of other measures. An overall coefficient of variation for organic content

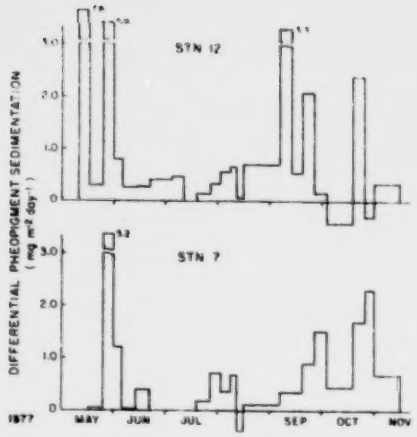

Fig. 34. Differential pheopigment sedimentation between depths shown in Fig. 29.

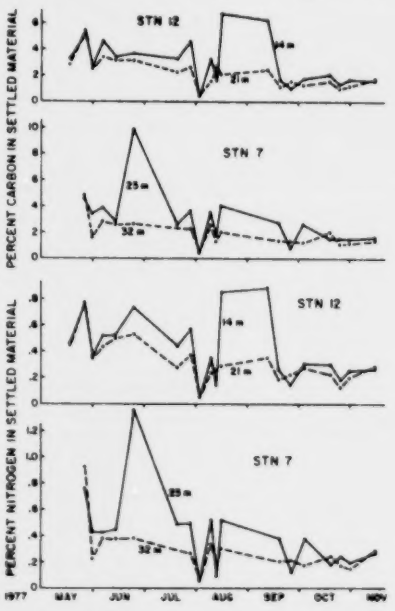

Fig. 35. Percent dry weight of material settled in cylinders as organic carbon and nitrogen at depths indicated at stations 12 and 7 in St. Georges Bay during 1977.

Table 19. Coefficients of variation ($\sigma/\bar{x}$) derived from measures of dry matter, carbon, nitrogen and plant pigments deposited in replicate (n = 3 or 4) cylinders suspended simultaneously at one depth. Data presented in Appendix V.

		Dry Weight	Percent Carbon	Percent Nitrogen	Chlorophyll a	Pheopigments
October 18/77						
Station 12	14 m	0.04	0.31	0.32	0.35	0.23
	18	0.04	0.06	0.06	0.32	0.08
	21	0.05	0.33	0.36	0.79	0.45
Station 7	25 m	0.10	0.80	0.82	0.27	0.23
	30	0.16	0.45	0.46	0.18	0.35
	32	1.20	0.20	0.50	0.21	0.29
October 25/77						
Station 12	14 m	0.09	0.16	0.18	0.09	0.10
	18	0.02	0.10	0.13	0.08	0.09
	21	0.03	0.04	0.14	0.15	0.03
Station 7	25 m	0.03	0.03	0.10	0.18	0.09
	30	0.03	0.03	0.10	0.31	0.16
	32	0.06	0.11	0.19	0.07	0.16
Average		0.15	0.22	0.28	0.25	0.19

is ±24% of the mean value obtained from material settled in one trap. The comparable value for dry weight determinations (±15%) means that sedimentation rates of carbon, nitrogen and plant pigments in four traps exposed simultaneously vary within ±39% of values derived by analyses of organic material in one trap.

Percent carbon and nitrogen, which were usually present in similar concentrations in material deposited at both stations decreased during the period of observation (Fig. 35). Exceptions to this trend occurred in material trapped at the shallowest depth at each station during June and between August and September. While there was a general decrease in carbon and nitrogen content, there were also distinct minima in these measures during early June and August and in late September and October. These periods of reduced carbon and nitrogen in settled material corresponded to times when the carbon:nitrogen ratio increased (Fig. 36). The temporal changes imply periodic depositionof freshly produced organic matter which occurred simultaneously at each station. There was no indication that

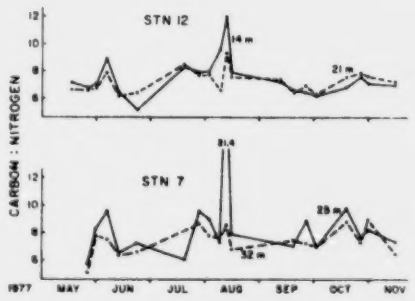

Fig. 36. Ratio of organic carbon:nitrogen (by weight) in material settled in cylinders at depths indicated at stations 12 and 7.

resuspended material (likely to have increased carbon:nitrogen values) was more abundant at either station.

Intermittent supply of particulate matter derived from phytoplankton and macrophyte production is illustrated by seasonal changes in chlorophyll *a* and pheopigment content in settled material (Fig. 37). Periods of low pigment concentration correspond to times (early June and August and late September) of minimum carbon and nitrogen content. Concentrations of plant pigments varied between depths but there was no clear depth-dependent trend. Higher values of chlorophyll *a* in traps exposed nearer to the surface and pheopigments in cylinders closest to the bottom might have been expected if freshly produced organic matter settled from the surface while resuspended material contributed substantially to deposition in near-bottom cylinders.

Seasonal differences in the quality of settled material based on variation in pigment content are also evident when chlorophyll *a* is expressed as a percentage of total pigment present (Fig. 38). While possible degradation of functional pigments during collection and uncertainty concerning quantification of pheopigments by fluorescence spectroscopy prevent unambiguous interpretation of calculated values of pigment concentration, there was a clear seasonal pattern which was similar at both stations and all depths. Minimum chlorophyll *a* (relative to total pigment content) was present between late July and mid-September. The abrupt changes which occurred simultaneously at different depths support the idea that the supply of freshly produced organic matter to material settled in traps occurs as intermittent pulses at approximately 4 to 5 week intervals between May and November.

Correlations between organic composition of material settled seasonally at different depths (independent of the amount deposited) can be used to examine similarities and infer common sources of origin. For example, changes in percent carbon and nitrogen in material settled at 21 and 32 m were significantly correlated (Table 20). Either seasonal events at these depths at both stations affected the organic content in similar ways or material was transported between these depths at a rate rapid enough that the organic content did not change. However, neither chlorophyll *a* nor pheopigment content in material settled at these or other depths was correlated to a similar degree. Also, while all coefficients are positive, with more than half of the correlations significant ($p < 0.05$), in general there was weak coherence in seasonal changes in the organic composition of particulate matter deposited at different depths.

These vertical differences could result if horizontal transport of particulate matter occurred in depth layers less than 3 to 5 m

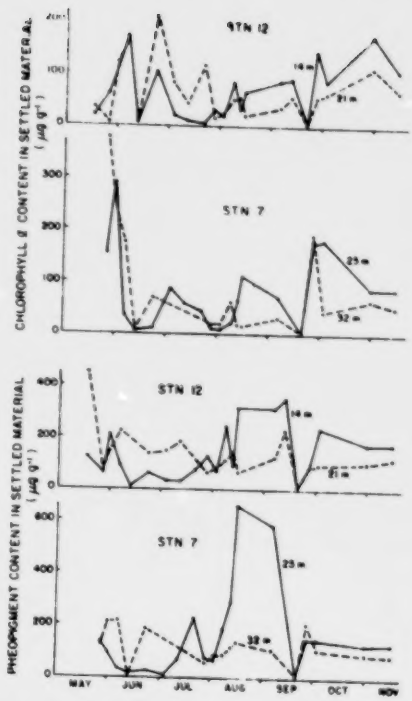

Fig. 37. Chlorophyll *a* and pheopigment content in material settled at depths indicated at stations 12 and 7 in St. Georges Bay during 1977.

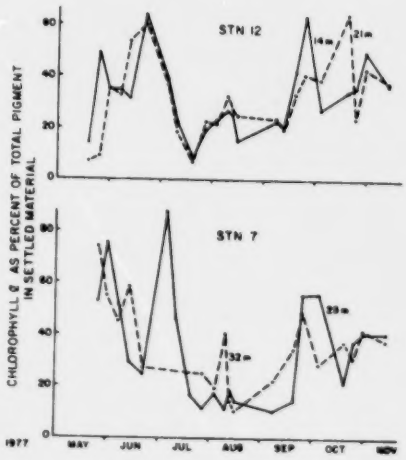

Fig. 38. Seasonal changes in chlorophyll *a* content in settled material expressed as a percentage of total pigment (chlorophyll *a* + pheopigment) present.

Table 20. Correlation coefficients (values of r) derived from linear regression analyses comparing organic carbon, nitrogen, chlorophyll *a* and pheopigment content in material sedimented at different depths at two stations in St. Georges Bay during 1977 (n = 19).

		Station 12		Station 7		
Depth (m)		18	21	25	30	32
Percent Carbon	14	0.56	0.38	0.36	0.46	0.52
	18		0.54	0.56	0.51	0.41
	21			0.34	0.50	0.86
	25				0.24	0.31
	30					0.33
Percent Nitrogen	14	0.61	0.45	0.58	0.27	0.46
	18		0.50	0.41	0.21	0.30
	21				0.18	0.84
	25				0.001	0.33
	30					0.16
Chlorophyll *a*	14	0.38	0.42	0.25	0.59	0.18
	18		0.55	0.01	0.67	0.06
($\mu g\ g^{-1}$)	21			0.06	0.49	0.07
	25				0.11	0.38
	30					0.55
Pheopigments	14	0.33	0.01	0.67	0.06	0.18
	18		0.35	0.17	0.07	0.38
($\mu g\ g^{-1}$)	21			0.0002	0.13	0.38
	25				0.05	0.16
	30					0.09

thick (the vertical distance beween moored traps). Although closely spaced vertical samples for determination of suspended particulate carbon and nitrogen were not taken, there were often large differences in concentrations over 5 m depth intervals (Appendix I). Material settled in cylinders spaced at 1 to 2 m apart between 20 and 25 m on October 18 and 25, however, did not show significant variation in either total dry weight settled or percent carbon, nitrogen or chlorophyll *a* content (Appendix IV). Pheopigment content in settled material was not similar at all depths, however. Thus, horizontal transport processes may occur during periods of mixing when vertical differences in the organic content of particulate matter over depth should be small.

6. SEDIMENTARY ORGANIC MATTER
(B. Hargrave and G. Phillips)

Observations in St. Georges Bay during 1976 (Prouse and Hargrave, 1977) showed the temporary formation of regions of lower temperature and higher chlorophyll a concentration nearshore along transects normal to shore. Observations reported here (Sections 1 and 3) and by Drinkwater and Taylor (1979), however, indicate that a stable nearshore temperature gradient was not established between May and November 1977.

Measures of sedimentary organic matter, as organic carbon, nitrogen and chlorophyll a and pheopigments, were carried out during 1977 to test the idea that processes of primary production and sedimentation enhance the organic content of nearshore sediments. While physical processes which increase biological productivity in nearshore areas may act intermittently and not be sustained over periods sufficient to enhance production by phytoplankton, an indication that enrichment has occurred might exist in the amount and nature of organic matter in bottom deposits. These comparisons, however, assume that postdepositional consumption, degradation, and transport of sedimented organic matter are similar in areas being compared.

Measures of sedimentary organic content, presented in Appendix V and summarized as averages for all observations in Table 21,

Table 21. Organic carbon, nitrogen and plant pigments in bottom sediment from two stations in St. Georges Bay. Measurements (n) were made at approximately weekly intervals, June-November 1977. Data are summarized from Appendix V.

Variable	Station	n	Mean		c.v.
Percent Organic Carbon	12	16	0.93	0.53	0.57
	7	14[a]	1.00	0.34	0.34
Percent Nitrogen	12	16	0.11	0.06	0.55
	7	15	0.13	0.05	0.38
Chlorophyll a ($\mu g\ g^{-1}$)	12	17	17.1	14.1	0.80
	7	18	18.0	16.1	0.90
Pheopigments ($\mu g\ g^{-1}$)	12	17	37.5	38.0	1.01
	7	18	41.2	48.9	1.18

[a] Value for organic carbon on 15/8/77 omitted from calculation of this mean.

show that no significant differences (t-test, $p < 0.05$) existed for the variables measured at stations 7 and 12. Variability of organic carbon and nitrogen throughout the period of study at station 7 ($\sigma/\bar{x}$ = 0.34 - 0.38) was less than that at station 12 (0.55-0.57), as might be expected form the uniform fine sand sediment characteristic of deposits in the central area of the bay (Kranck, 1971). Chlorophyll a and pheopigment concentrations, on the other hand, were more variable (c.v. = 0.80 - 1.18) but measures of seasonal variation in pigment content were lower at station 12 than at station 7. Average carbon:nitrogen ratios (by weight) of 8.5 and 7.7 and chlorophyll a as a percent of total pigment of 31.3 and 30.4% for station 12 and 7 respectively, show the similarity in composition of organic matter at the two stations.

Changes in organic content over time also show that sediments at stations 12 and 7 underwent seasonal fluctuations which were not only similar in magnitude but also synchronous over time (Fig. 39). Chlorophyll a content in sediments at both stations was maximum during early July, August, and October, times when organic carbon and nitrogen content also increased. Thus, depositional events which supplied organic matter to sediments at both stations must have occurred simultaneously despite differences in water depth. Similarly,

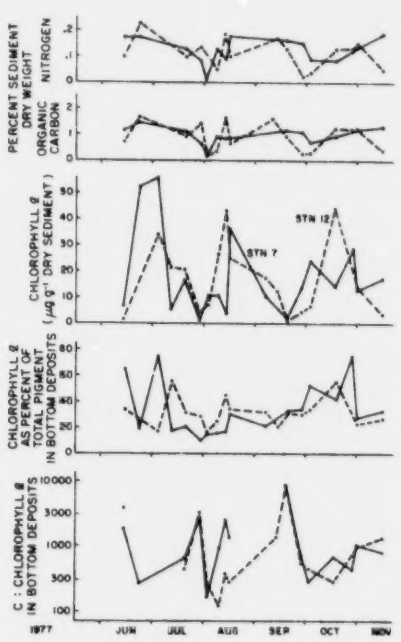

Fig. 39. Seasonal changes in sedimentary organic carbon, nitrogen, and plant pigment content at stations 12 and 7 in St. Georges Bay during 1977.

seasonal changes in sedimentation at both stations (Section 5) showed that periodic deposition of freshly produced organic matter occurred simultaneously at both stations.

Previous studies in Bedford Basin have shown that values of the carbon:chlorophyll *a* ratio and chlorophyll *a* content expressed as a percentage of total plant pigment present in sediment can be used to infer when deposited material is derived from sedimenting phytoplankton (Hargrave and Taguchi, 1978). Low values (<300) of the carbon:chlorophyll *a* ratio in bottom deposits in St. Georges Bay coincided with periods when chlorophyll *a* accounted for more than 30% of total pigment content, indicating that photosynthetically active algal cells were being sedimented into collection cylinders.

Comparison of the carbon:chlorophyll *a* ratio measured in particulate material settled in traps moored 1 m above the bottom with that measured in underlying surface sediments sampled on the date of trap retrieval (Fig. 40) show a positive correlation which is similar for samples collected at both stations over the duration of the study. Even though resuspension would tend to make these values similar, the correlation shows that sediments at both stations respond to seasonal changes in the quality of deposited material in a similar way.

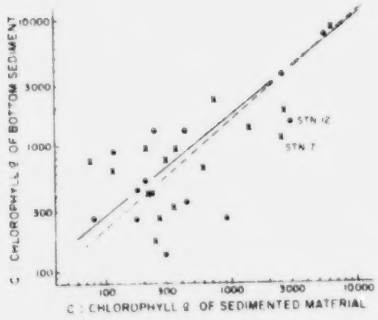

Fig. 40. Comparison of organic carbon:chlorophyll *a* in surface sediment and material deposited in cylinders moored 1 m above the bottom at two stations in St. Georges Bay during 1977. Solid line (data from station 7), y = 176 + 1.06x. Dotted line (data from station 12), y = 155 + 1.12x.

GENERAL DISCUSSION

Onshore-Offshore Gradients

One aim of our study in St. Georges Bay during 1977 was to determine if a nearshore zone of increased biological productivity occurred. Surface water samples collected along a transect during 1976 implied that a nearshore cold water zone rich in chlorophyll *a* formed temporarily during July and August (Prouse and Hargrave 1977). Upwelling of subsurface water could account for increased biological production inshore through enhanced nutrient supply. On theoretical grounds, upwelling in the Bay should be restricted under stratified conditions within a zone extending approximately 3 km offshore (Drinkwater and Taylor 1979).

Data collected during 1977 at station 12 (3 km offshore) and station 7 (9 km offshore) were subjected to a paired 't' test to determine if significant differences existed between the two stations. Two time periods were considered, the full period of observation (April to November) and the shorter time interval of June to mid-September which coincided with the most intense vertical stratification of the water column. Surface and integrated (0-15 m) chlorophyll-*a*, temperatures averaged over the upper 15 m plus integrated (0-15 m) concentrations of ammonia, nitrate and nitrite showed no statistically significant difference ($p > 0.1$) during either time period. Significant differences were found in integrated (0-15 m) phosphorous and silicate concentrations during April to November ($p = 0.05$ and 0.07 respectively). The differences were on the order of 10 to 20% with concentrations at station 12 exceeding those at station 7. These differences may be related to the shallower depth or nearer shore location of station 12 assuming the sea bottom or shoreline are important sources of these nutrients. Integrated (0-15 m) primary production was also statistically significantly different between the two stations ($p = 0.06$) during the stratified period but not during the full observational period April to November ($p = 0.15$). Phytoplankton production at station 12 was approximately 10% higher during the stratified period.

Higher rates of organic carbon and nitrogen deposition also occurred at the inshore station in all months except June and July. Resuspension could have increased sedimentation at station 12 because of its shallow depth; however, to minimize this effect measurements from traps suspended 8 m above the bottom were compared at both locations. Organic carbon deposited at station 12 was 50% higher than that at station 7, while nitrogen deposition was increased by 32% over the months May to October.

It appears that on average a slight increase in production occurs inshore relative

Table 22. Average temperature and mixed-layer depth, integrated monthly total phytoplankton production, average concentration of suspended plant pigments, dissolved silicate and ammonia, plankton biomass and monthly total sedimentation of organic carbon, nitrogen and chlorophyll a at station 7 in St. Georges Bay during 1977.

Month	Temperature (C)		Mixed Layer Depth	Phyto-Plankton Production	Suspended Pigments		Silicate	Ammonia	Plankton Biomass 25-2000 µm	Plankton Biomass 509-2000 µm	Sedimentation Carbon	Sedimentation Nitrogen	Sedimentation Chl.a
	5 m	20 m	(m)	g C m^{-2}	Chl. a mg m^{-2}	Pheo.	mg at m^{-2}		mg d wt m^{-3}		g m^{-2}	g m^{-2}	mg m^{-2}
Variable	T_5	T_{20}	Z_m	PP	SChl	SPhe	SiO_4	NH_4	TPB	LPB	CS	NS	ChlS
May	5.7	3.8	15	3.2	9.2	2.5	41.7	24.9	113.0	11.2	3.8	0.52	11.8
June	9.8	5.5	10	5.1	14.8	10.0	67.4	28.0	98.8	18.4	1.5	0.21	2.7
July	15.8	13.8	15	7.4	8.3	6.2	92.9	100.8	104.0	12.2	1.6	0.23	4.1
August	20.5	17.6	20	12.7	16.7	5.0	166.2	124.1	55.7	7.9	1.1	0.19	3.3
September	19.4	15.9	25	14.0	19.3	7.9	119.1	21.4	60.9	7.3	3.9	0.55	5.9
October	11.2	11.2	30	11.1	32.3	9.1	167.5	28.5	99.8	11.9	3.8	0.49	24.5

to offshore when the water column is stratified. the data are not sufficient to determine the cause of such an inshore increase in production.

Seasonal Relations Between Observations

To determine if any broad scale seasonal relationships existed between the variables we measured, all observations were averaged or integrated over monthly intervals (Table 22) and then correlated (Table 23). The matrix of simple linear correlations shows that phytoplankton production was directly correlated with temperature (at 5 and 20 m), dissolved silicate concentrations and total plankton biomass. Suspended chlorophyll *a* also increased in concentration as mixed-layer depth deepened and silicate concentration increased over the six months. Suspended pheopigment concentration on the other hand, while increasing during the study, was not significantly correlated with any other variable measured. Dissolved silicate and ammonia concentrations were positively correlated with both temperature and phytoplankton production. Suspended chlorophyll *a* concentrations showed positive coherence with seasonal changes in seidmentation of chlorophyll *a*. Carbon and nitrogen deposition were also positively correlated with chlorophyll *a* sedimentation and inversely related to dissolved ammonia concentration. No other correlations except between temperature at 5 and 20 m were significant.

These calculations provide a simple and direct assessment of similarity of seasonal changes in different variables. The coefficients themselves are of little quantitative value because of the small number of observations. Qualitatively, however, the sign and relative magnitude of the coefficients are useful. For example, positive correlations between phytoplankton production, dissolved silicate and ammonia concentrations, and temperature show that nutrient supply to the water column increased with temperature during the summer, despite utilization by phytoplankton. However, an inverse relation existed between concentrations of these nutrients and total plankton biomass. Release of inorganic excretory products by large (25-2000 μm) planktonic organisms as discussed below could have contributed to the accumulation of inorganic nitrogen. Consideration of changes in discrete size class of plankton may be required to demonstrate relationships between changes in biomass and nutrient concentration. Nutrients must also be supplied from other sources in the water column (heterotrophic microplankton for example), from sediments or by transport into the bay. Stable vertical gradients during stratification, with increased concentrations close to the bottom (Fig. 7), show that benthic nutrient regeneration is probably a major pathway of supply.

The correlations also show that deposition of particulate carbon, nitrogen, and chlorophyll is more directly related to water stratification and phytoplankton standing stock than to rates of phytoplankton production over the duration of the observations.Monthly sedimentation of carbon nitrogen and chlorophyll were poorly correlated with phytoplankton production; however, there were positive correlations with mixed-layer depth, suspended chlorophyll, and dissolved ammonia concentration. These relations imply rapid recycling of products of phytosynthesis through a tightly coupled food-web in the upper mixed layer. Material deposition should represent a small fraction of that produced over a short time interval as calculations discussed below demonstrate.

Further comparisons between variables summarized in Table 22 and other observations made during the study are made difficult by the different time scales and frequencies of response involved in the measurements. For example, daily means of surface wind speed and direction were not statistically significantly correlated with either absolute measures of sedimentation or differential sedimentation between depths at either station 7 or 12. Wind-induced events, due to the passage of atmospheric pressure systems, occurred at approximately three to five day intervals Drinkwater and Taylor 1979). Measurements of sedimentation over weeky exposure periods could not be used to detect short-term effects of such events. Similarly, there was no statistical significant correlation between sedimentation and water current speed and direction measured simultaneously at three depths during July and August. Six hour average current speed values were calculated to filter out high frequency events for comparison with weekly average particulate deposition rates. Current direction was divided into 20° intervals and cumulative average velocity was calculated over times corresponding to sediment trap exposure. No correlations were apparent between either rates or directions of current flow and sedimentation.

Drinkwater and Taylor (1979) observed on occasion that events (periods of above average rates) in current measurements occurred simultaneously at different depths during July and August in St. Georges Bay. These did not correspond to local wind events but the three largest events occurred during passage of low pressure systems. It appears that persistent currents or intermittent circulation features, such as coastal jets or those associated with internal waves, all of which should affect deposition, erosion, and transport of particulate matter, cannot be simply related to atmospheric forcing. In addition, without short-interval measurements of deposition, quantitative relations between these oceanographic variables and sedimentation cannot easily be established.

Table 23. Simple linear correlation coefficients (r) between variables listed in Table 22. n = 6 in all cases, * indicates significance at $p < 0.1$. Letters correspond to variables as presented in Table 22.

	T_{20}	Z_m	PP	SChl	SPhe	SiO_3	NH_4	TPB	LPB	CS	NS	ChlS
T_5	0.96*	0.33	0.84*	0.10	0.10	0.65	0.60	-0.87*	-0.62	0.39	-0.28	-0.42
T_{20}		0.51	0.89*	0.22	0.10	0.77*	0.62	-0.80*	-0.70	-0.22	-0.17	-0.20
Z_m			0.76*	0.86*	0.51	0.29	0.05	-0.70	-0.46	0.41	0.41	0.57
PP				0.58	0	0.86*	0.24	-0.84*	-0.69	0.10	0.14	0.06
SChl					0.58	0.74	-0.31	-0.22	-0.12	0.40	0.36	0.73
SPhe						0.29	-0.33	-0.08	0.46	-0.06	-0.12	0.11
SiO_3							0.38	-0.61	-0.49	-0.06	-0.06	-.32
NH_4								-0.35	-0.29	-0.76*	-0.73	-0.44
TPB									0.65	0.18	0.10	0.37
LPB										0	-0.38	-0.05
CS											0.49	0.68
NS												0.62

Physical and Biological Control of Dissolved Nutrient Distributions

Observations of dissolved inorganic nutrients in St. Georges Bay during 1977 are consistent with the view that water within the Bay has a residence time of at least several weeks during the summer. No information is available about nutrient concentrations in water outside the Bay and changes could occur through water exchange with Northumberland Strait. However, cumulative increases in silicate concentration from May through August were largely due to increased concentration below the nutricline. While movement of nutrient-rich water into the Bay could be responsible, release from sediments at depths below the mixed layer and reduced vertical mixing due to strong stratification could have caused the concentrations to rise in bottom layers. Dissolved nutrient concentrations above the nutricline would not be expected to be appreciable since utilization by phytoplankton should occur. The persistence of anomalously high ammonia concentrations in surface water layers throughout the summer until August implies that the supply of this nutrient, presumably through regeneration, did exceed utilization.

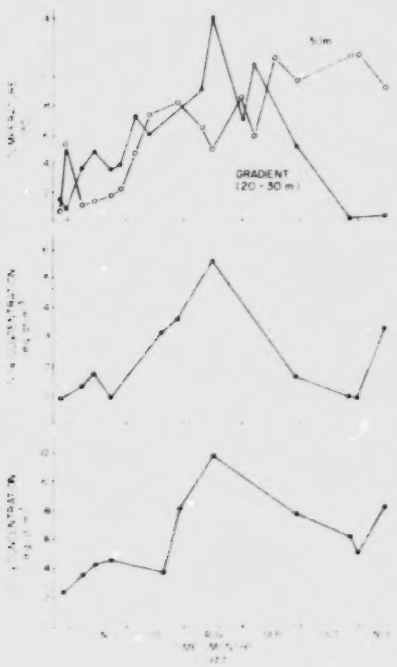

Fig. 41. Changes in temperature at 30 m, the temperature gradient between 20 and 30 m, and mean dissolved ammonia and silicate concentration between 20 and 30 m at station 7 in St. Georges Bay during 1977.

The combined importance of physical and biological factors in regulating dissolved nutrient distribution is illustrated by seasonal changes in water temperature, stratification and nutrient concentration in St. Georges Bay (Fig. 41). As mixed-layer depth and water temperature progressively increased from May to August, gradients in temperature and in the concentration of dissolved nutrients between the mixed layer and bottom increased. There was a positive correlation of the temperature gradient between 20 and 30 m with integrated concentrations of ammonia and silicate in the lower 10 m of the water column. Maximum values were reached by mid-August and thereafter, as the mixed layer deepened, the reservoir of accumulated nutrients could have been mixed into the surface water or possibly diluted by exchange with water in Northumberland Strait.

The absence of large changes in dissolved phosphate, nitrate or nitrite concentrations, except following October when flushing of the Bay could have caused water exchange (Figs. 8 and 9, Section 2), shows that rates of regeneration and/or biological utilizaton of these compounds were not similar to those for silicate and ammonia. While stratification appeared to allow accumulation of all nutrients below the nutricline, biological uptake reduced dissolved concentrations near the surface. In fact, the extent of net nutrient depletion in surface water may be directly related to the rate of that nutrient's turnover. Thus, between June and September phytoplankton producton was maximum (Fig. 11, Section 3), when dissolved nitrate and nitrite were present in lowest concentrations.

Increasing ammonia concentrations between June and August would not be expected if rapid uptake by phytoplankton occurred. Regeneration from bottom sediment and from planktonic organisms within the water column, which exceeded phytoplankton requirements, seemed the most likely cause for such accumulation. The increase was greater at station 7 for the total water column (Fig. 8) and for waters above 15 m (Fig. 9, Section 2).

The significant positive correlation between monthly phytoplankton production, suspended chlorophyll a concentration, and average silicate concentration (Table 23) shows that seasonal trends in algal biomass and primary production and the abundance of this dissolved nutrient were similar. Temperature was positively correlated with all of these variables (Table 23), however, hence the casual relations between primary production and nutrient concentration cannot be inferred. Since dinoflagellates were the predominant phytoplankton between April and November Section 4), it seems probable that the accumulation of silicate reflects its lack of utilization. Also during late October and November, when phytoplankton production declines sharply (Fig. 11, Section 3), silicate concentrations

above 1 m were the highest observed (Fig. 9, Section 2). These observations imply that silicate might be considered a conservative property of water mass circulation during certain periods of the year in St. Georges Bay. Reduced phytoplankton production after stratification disappeared in October probably resulted from mixing of algal cells below the compensation or critical depth. Thus, despite the presence of abundant dissolved inorganic nutrients, increased phytoplankton production could not be realized because of light limitation.

Seasonality of Dissolved Inorganic Nutrients and Plankton Biomass

Observed levels of suspended chlorophyll a and phytoplankton production (Section 3) imply that pulses of phytoplankton production occurred at four to five week intervals. The frequency and amplitude of these fluctuations were approximately the same at both inshore and offshore stations (Fig. 14), allowing for differences in water depth. High population densities of phytoplankton correspond with or closely follow the pulses in production which occurred during early June, early July, mid-August, and late September. An earlier spring 'bloom' must have occurred prior to our sampling period to account for the high pigment values found in suspended material on April 18 (Fig. 11).

The fluctuations in phytoplankton production coincide or are slightly lagged with high concentrations of total inorganic nitrogen in the surface water layer from April until the middle of August. This is possibly a casual relationship since NH_4 concentrations increased steadily during this period. The fall 'bloom', during late September, occurred when total nitrogen was low but this was based on only one nutrient sampling date between August 15 and October 25. Following the establishment of a well mixed water column in early October nutrient concentrations climbed steeply and primary production declined (Figs. 8 and 14). The mixed layer depth increased continuously throughout the summer until it reached the bottom in early October (Figs. 4 and 5). This gradual deepening of the upper layer reduces the residence time of the phytoplankton population in the upper euphotic zone and is therefore believed to have contributed to the observed reduction in production during October.

Our observations also imply that herbivore abundance and thus grazing pressure may be associated with the fluctuating nature of the nutrient concentrations and standing stock of phytoplankton populations. Plankton biomass was sampled from April 26 to November 15, 1977, at the central bay station, and fractionized into logarithmic size classes (see Section 4). This method combines a diverse flora and/or fauna in each size fraction which necessarily obscures the population dynamics of individual species. It does, however, enable one to roughly trace size-specific cohorts as they develop through the planktonic community, with the assumption that similar-sized organisms are of the same general feeding type. In actual fact, greater than 90% of the organisms in the four size-classes between 66 and 1028 μm are copepods and one species dominates at any particular time of year.

The biomass in each size fraction between April and November is shown in Figure 42 together with total inorganic nitrogen, suspended chlorophyll *a*, and phytoplankton photosynthetic rate. The 25 to 66 μm fraction, comprised largely of algal cells and tintinids, does not appear to bear any consistent relation to the total chlorophyll *a* measured in the water column. Obviously, at times most of the chlorophyll *a* is associated with cells smaller than 25 μm. There are several clear seasonal patterns in the next four size fractions which enable us to follow the development of copepods from egg to adult. If lines are drawn by eye between peaks of adult copepod abundance (505-1028 μm fraction) and the nearest preceding peak in copepod egg and nauplii, the intermediate peaks in early copepodids (125-250 μm) and late copepodids (250-509 μm) tend to fall in between. This is encouraging when one considers that sampling date were two weeks apart.

From this, we can identify three major size cohorts in the community. The first generation appears to be the result of the spring 'bloom' which occurred before our sampling began. The second aligns with the early June chlorophyll *a* peak, and the third generation corresponds to the late September peak. The first and second generation lines occurred when *Temora longicornis* dominated the *Calanus-Temora-Pseudocalanus* comunity (see Fig. 22). Paffenhöfer and Harris (1976) and Harris and Paffenhöfer (1976) report generation times of approximately 28 days for both *Temora longicornis* and *Pseudocalanus minutus* at 12.5°C, which means our value for the slope of generation line 2 is credible (Fig. 42). Generation line 1 is less steep which one would expect from copepod development at lower temperatures. The third or fall zooplankton generation occurs after the *Centropages-Tortanus-Acartia* successional community has taken over (see Fig. 22). Person-LeRuget (1975) estimates generation lengths of 21 days for both *Centropages hamatus* and *Acartia clausa* at 20°C, which matches the slope for the development of our fall generation (Fig. 42).

All of these estimates of generation times are within the estimated average flushing time of the Bay (Petrie and Drinkwater 1978). It appears, then, that the plankton biomass data is consistent with lagged zooplankton predation on phytoplankton

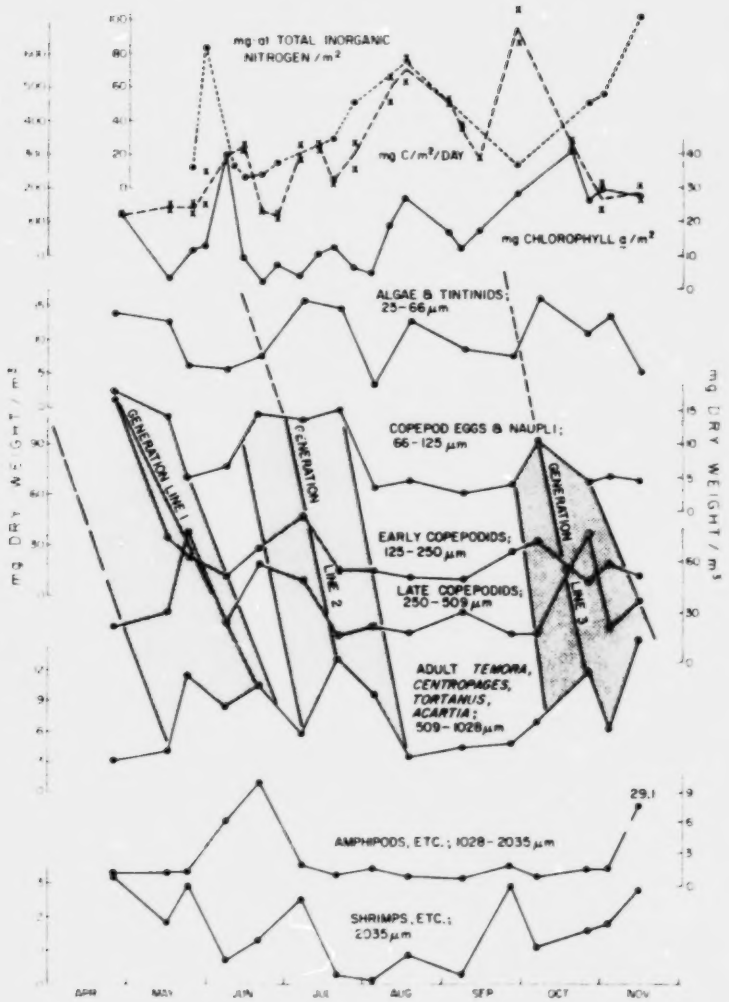

Fig. 42. Total inorganic nitrogen, suspended chlorophyll a, phytoplankton production and biomass of various size fractions of plankton near a central station in St. Georges Bay during 1977.

populations such that peaks of chlorophyll *a* are followed by successive peaks in copepod egg and nauplii, early, late, and finally adult copepod biomass. There is, however, a noticeable lack of larger-zooplankton biomass, and therefore predation control, on and following the mid-August chlorophyll *a* maximum. It is possible that tintinids in the 25 to 66 µm fraction, themselves relieved from predation, managed to contain the phytoplankton population. The chlorophyll *a* deposited in sediment traps and in bottom muds discussed below, however, shows that products of these 'blooms' also settled out of the water column. The lag in appearance of copepod nauplii following the early June and late September chlorophyll *a* maxima is around 12 days. The phytoplankton population is probably kept in check by zooplankton grazing and algal settlement but with a sufficient grazing lag period to enable peaks of chlorophyll *a* to occur.

Specific production by phytoplankton increased as chlorophyll *a* concentrations were reduced during late June, early July, and again in late July (Figs. 11 and 15) possibly indicating some density-dependent effect. It has been mentioned above that zooplankton grazing can play an important role in controlling phytoplankton populations. Zooplankton also excrete nutrients in the euphotic zone and it appears that the second generation line zooplankters could have contributed to the late July to early August increase in ammonia concentrations (Figs. 8, 9, and 41). The presence of inorganic nitrogen and high light initiates phytoplankton production once thermal stratification is established. However, the relative importance of nutrient deficiency, algal setling, and zooplankton grazing in terminating a 'bloom' is not clear. Information is needed on an *in situ* inorganic nitrogen regeneration and on zooplankton grazing rates before the relative importance of these interacting processes can be evaluated.

The overall rise in chlorophyll *a* concentrations during late summer and fall, caused by intermittent pulses in production, indicates that net phytoplankton population growth exceeded grazing and depositional loss. Table 14 illustrates the successional nature of the phytoplankton community in St. Georges Bay. Phytoplankton species which are experiencing heavy predation and other less-than-favourable environmental conditions are being replaced by new species assemblages during a time scale of weeks.

The two largest size categories, amphipods, and pteropods, etc. (1028-2035 µm), and decapods, etc. (>2035µm), have generation times (one year or more) which are too long to compare meaningfully with the small scale summer and fall pulses of primary production discussed above. Both these size fractions have consistently low biomass values during the summer. The November rise in biomass of the 1028 to 2035 µm size-class was due to a dramatic influx of *Limacina* from outside the Bay after the water column became homogeneous. These pteropods probably contributed to the observed chlorophyll *a* decline in November. As discussed in a previous section, *Pandalus* shrimp comprised most of the largest size fraction sampled. It is not known whether *Pandalus* were absent during the summer because they stopped migrating off the bottom, moved out of the Bay, or were consumed by demersal fish.

Seasonal Variation in Organic Supply to Sediments and Benthos

Previous studies of sedimentation in marine coastal waters have shown that a variety of seasonal patterns can occur. Our observation of low rates of particulate deposition during summer stratification with much higher rates during spring and fall (Fig. 26) are comparable to previous studies in St. Georges Bay, St. Margaret's Bay, and Bedford Basin (Webster et al. 1975, Hargrave et al. 1976, Prouse and Hargrave 1977). In all of these studies, dry weight of particulate matter settled in collectors suspended well off the bottom varied between 1 and 5 g m^{-2} day^{-1}. Traps suspended close to the sediment in these and other studies collected more material than those placed at shallower depths. The presence of a near-bottom nephaloid layer, caused by resuspension of bottom material, results in high deposition rates in collectors exposed close to the sediment.

Resuspension of material in St. Georges Bay appears to transport particles up to at least 8 to 9 m above the bottom, since increased deposition during periods of low stratification occurred simultaneously at all depths at both stations (Fig. 26). Considerable vertical and horizontal transport of particulate matter must occur during unstratified periods. If increased deposition in near-bottom collectors is assumed to reflect these resuspension processes, the least amount of resuspension and transport of material occurred between June and August when steep density gradients were present in the water column (Figs. 31-35). This is consistent with the estimates of a relatively long residence time for water in the Bay during the period of strongest stratification (Petrie and Drinkwater 1978a).

Periodic enrichment of organic carbon and nitrogen (Fig. 35) and plant pigments (Fig. 37) in deposited material and in bottom sediments (Fig. 39) was observed despite the presence of resuspended material. These pulses in organic matter coincided with periodic increases in phytoplankton standing crop (Fig. 43). These measurements of organic matter in settled material and bottom sediments decreased rapidly during intervals

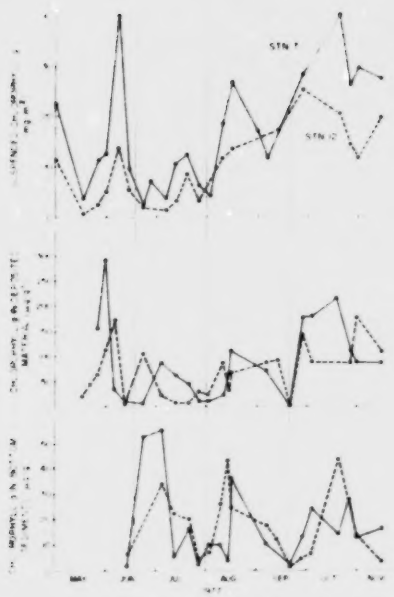

Fig. 43. Changes in chlorophyll a content suspended in the water column, in material settled in sedimentation traps, and in surficial bottom sediments at two stations in St. Georges Bay during 1977. Vertical lines drawn at times when low concentrations indicate the cessation or initiation of successive periods of chlorophyll a enrichment.

between blooms. The similarity of the carbon chlorophyll a ratio in bottom sediments and material settled in traps (Fig. 40), and the temporal changes of organic matter in deposited material, imply that the lack of accumulation of organic matter in sediments at stations 7 and 12 in St. Georges Bay is attributable to rapid and almost complete oxidation of material before and soon afer deposition. As long as the flux of relatively organic-rich material continues from the water column, organic carbon content of bottom sediment is maintained at approximately 1%. When this supply is interrupted concentrations of organic matter remaining in sediments decrease rapidly.

This apparently tight coupling between the supply of oxidizable particulate matter from the water column, organic content of settled material and that accumulated in bottom sediments, is probably due to the shallow depth and relatively high summer temperature (Fig. 41) in St. Georges Bay. Changes in organic production in surface water are reflected by changes in the quantity and quality of particulate matter deposited. The amounts of organic carbon in settled material (0.5-10% of dry weight) relative to that in bottom sediments (0.2-1.8%) (Fig. 35 and 39), however, show that efficient oxidation of recently deposited particulate matter occurs. These values of percent dry weight of settled material as organic carbon (or nitrogen) are lower than has been observed in other studies in nearby coastal marine waters. In St. Margaret's Bay, for example, organic carbon comprised 10 to 14% of the dry weight of deposited material in early summer with values of 5% during winter (Webster et al. 1975). Macrophyte production probably contributed detritus to produce high rates of organic matter deposition at the time studies were conducted in this bay. Values of 5 to 20% of sediment dry weight as organic carbon occurred in Bedford Basin during an annual study (Hargrave et al. 1976). While macrophytes do not contribute substantial amounts of organic carbon, phytoplankton production is relatively high and the embayment is enriched with sewage and river discharge (Hargrave and Taguchi 1978).

These differences imply that in St. Georges Bay planktonic predator-prey links during the summer are tightly coupled. Respiration of much of the organic matter synthesized by phytoplankton must occur in the water column. This conclusion is supported by comparisons of phytoplankton production and sedimentation (Table 24). While not only phytoplankton but also resuspended debris settles into traps, the calculations show that phytoplankton production is more than sufficient to account for observed rates of deposition. As in Bedford Basin (Hargrave 1980), sedimentation of organic carbon in St. Georges Bay is equivalent to between 10 and 20% of that produced by phytoplankton during periods of stratification. In late spring and fall, however, mixing in the water column could cause a higher proportion of organic matter produced by phytoplankton to reach the benthos. The six-month total values for sedimentation were equivalent to 29 to 32% of phytoplankton production. An earlier comparison of carbon supply and sedimentation in different water bodies showed that with a mixed-layer depth of 15 m approximately 30% of the carbon supply to the water column would be deposited (Hargrave 1975). These comparisons do not consider the flux of organic matter present in migrating planktonic and benthic organisms. Further studies in St. Georges Bay will be necessary to determine the amount of organic matter settled which remains to be oxidized in the sediments.

Higher sedimentation rates at station 12 than at station 7, with similar rates of phytoplankton production on a square metre basis at the two locations (Table 24), means that organic carbon and nitrogen deposition corresponds to a slightly higher proportion of phytoplankton production at station 12 (33-38%) than at station 7 (28-29%). Resuspension of previously settled material occurs more extensively at the shallow station (12) as higher rates of differential sedimentation

Table 24. Monthly phytoplankton production (integral values 0 to 15 m from Table 6) and sedimentation at two stations in St. Georges Bay during 1977. Nitrogen requirements of phytoplankton calculated from carbon fixation rates assuming a carbon:nitrogen ratio of 7.0. Sedimentation measured at 25 m at station 7 and 14 m at station 12 with values measured between May 15 and 30 multiplied by two to estimate the monthly total for May.

Month	Phytoplankton Production gC m^{-2}	gN m^{-2}	Sedimentation gC m^{-2}	gN m^{-2}		Sedimentation as a Percent of Production C	N
			Station 7				
May	3.2	0.5	3.8	0.5		119	100
June	5.1	0.7	1.5	0.2		29	29
July	7.4	1.1	1.6	0.2		22	18
August	12.7	1.8	1.1	0.2		9	11
September	14.0	2.0	3.9	0.6		28	30
October	11.1	1.6	3.8	0.5		34	31
	53.5	7.7	15.7	2.2	$\bar{x}$ of	29	
			Station 12				
May	3.7	0.5	5.0	0.7		135	140
June	4.8	0.7	1.1	0.2		23	29
July	9.9	1.4	1.1	0.2		11	14
August	14.9	2.1	1.9	0.3		13	14
September	15.1	2.2	6.5	0.9		43	41
October	12.5	1.8	3.8	0.5		30	28
	60.9	8.7	19.4	2.8	$\bar{x}$ of	32	

illustrate (Figs. 30-34). Between June and August, however, when resuspension is minimized, carbon and nitrogen deposition is similar at both stations (4.2 and 4.5 g C m^{-2}; 0.63 and 0.51 g N m^{-2} for station 7 and 12 respectively).

These comparisons do not consider the contribution of production by attached macrophytic algae. This could be substantial in nearshore regions of St. Georges Bay (less than 20 m depth) where hard substrates exist for attachment. Mann (1972) has shown that much of the organic matter synthesized by macrophytes in St. Margaret's Bay was released as soluble material or eroded as fine particulate matter. If this material was distributed horizontally from nearshore areas in St. Georges Bay, it would contribute to organic matter settled in traps at both stations in addition to that produced by phytoplankton. If tissue produced by macrophytes remained to accumulate in nearshore areas, without becoming suspended as fine particulate matter, our measures of deposition would underestimate this organic supply to the benthos.

Processes which cause resuspension enhance the horizontal and vertical transport of particulate matter in St. Georges Bay. They also extend the duration of exposure of particulate material for aerobic oxidation before permanent burial. The similarity in the timing and magnitude of seasonal changes in organic content of settled material and bottom sediments at both stations (Sections 5 and 6) shows that rapid mineralization of material has occurred at the shallow depths in the Bay. In deeper water, where the residence time of settling particles is increased,

Table 24. Monthly phytoplankton primary production (g C m^{-2} $month^{-1}$) in various coastal waters of Nova Scotia. In situ incubation with ^{14}C uptake used in all studies. Data from St. Georges Bay are integral values 0 to 30 m (Table 6).

Month	St. Georges Bay (1977) Stn 7	St. Georges Bay (1977) Stn 12	Bras D'Or Lake (1962)[a]	Gulf of St. Lawrence (1969-72)[b]	Scotian Shelf (1974-75)[c]	St. Margaret's Bay (1966-69)[d]	Bedford Basin (1973-74)[e]
May	4.6	3.7	3.7	18.3	7.4	13.0	10.2
June	6.7	4.8	11.7	12.5		11.8	33.6
July	8.7	9.9	9.4	14.0		7.7	20.8
August	14.7	14.9	12.8	13.8	5.9	17.4	21.8
September	15.5	15.1	7.4	10.1		25.0	23.0
October	12.1	12.5	13.5	6.4		21.1	15.2
6 month Σ	62.3	60.9	58.5	75.1		96.0	124.6
Annual Σ	-	-	-	212	97	190	200
$\frac{\text{6 month}}{\text{annual}} \cdot 100$				35.4		50.5	62.3

[a] Geen (1965) [hourly rates normalized to a standard light intensity of 175 g-cal cm^{-2} and multiplied by average day length given by Platt (1971) to calculate monthly values for Red Head station]
[b] Steven (1975) (data from central and eastern areas of the Gulf of St. Lawrence)
[c] Fournier et al. (1977) (annual estimate derived from measurements in March, May, August, and November)
[d] Platt (1971)
[e] Taguchi and Platt (1977) [annual estimate and monthly total values are comparable to measurements made in 1969-71 by Platt and Irwin (1971)]

significant differences in organic composition and susceptibility of deposited material to oxidation can occur (Hargrave 1978, Knauer et al. 1979). In St. Georges Bay concentrations of organic carbon and nitrogen were usually highest in material settled at the shallowest depth at both stations (Fig. 35). These differences did not exist in bottom sediments (Fig. 39) presumably because of extensive degradation which occurs rapidly after deposition.

Comparison of Biological Production in St. Georges Bay and Other East Coast Canadian Waters

Measurements over six months at two stations in St. Georges Bay show that spatial differences in phytoplankton specific production are small relative to the variance over time. These observations concur with those from previous studies of phytoplankton production in other coastal embayments in Nova Scotia. Geen (1965) concluded that a single determinaton of integral phytoplankton production in the Bras D'Or Lakes was representative of conditions over several days or longer. Platt and Filion (1973) and Platt (1975) also demonstrated that while spatial differences in phytoplankton specific production could be measured between several stations at certain times in Bedford Basin, these differences were small compared to variation between days. Therriault and Platt (1978) also estimated between station components of variance for different environmental factors related to phytoplankton biomass and productivity in St. Margaret's Bay. Considerable day-to-day variability in all factors existed whereas the spatial variances for different factors were not correlated.

These observations show that seasonal changes in phytoplankton biomass and production may be adequately represented by a sampling frequency of once each 7 to 14 days. Results of our study also show that this sampling frequency is acceptable for observing seasonal changes in zooplankton biomass and population structure, dissolved inorganic nutrient concentrations and organic content in bottom sediments. Measurements of

sedimentation, on the other hand, could be made over a shorter time interval than we have used to better resolve short-term changes in deposition rates.

Estimates of phytoplankton production in St. Georges Bay can be compared with measurements made previously in other coastal waters around Nova Scotia (Table 25). When data are calculated on a monthly basis, estimates from St. Georges Bay are similar to those for Bras D'Or Lake. Production in both areas between May and October, however, is lower than occurs in the Gulf of St. Lawrence, St. Margaret's Bay, and Bedford Basin. Estimates of phytoplankton production in these three locations show that between 30 and 60% of the total annual production occurred between May and October. Thus production during the winter and spring accounts for a large proportion of the annual total and the proportion is different in different areas. If a mean value of 50% is taken as the fraction which occurs during May and October, annual primary production by phytoplankton in St. Georges Bay could be as much as 118 g C m^{-2}. This is a moderate level of production comparable to preliminary estimates for the Scotian Shelf (Fournier et al. 1977).

An obvious question arising from our study is why, with an apparent excess of dissolved silicate and ammonia, is phytoplankton production not greater. One answer might be that the deep (from 10 to 25 m) average mixed-layer depth in the Bay creates conditions of light limitation for phytoplankton. Algal cells are mixed to, at, or below their compensation depth and net production is decreased. This deep mixing also means that temperature is increased in a larger proportion of the Bay. Higher temperature-dependent metabolic rates of bacteria, phytoplankton and their predators would control biomass accumulation, increase mineralization and decomposition of organic matter and reduce net photosynthetic production. The observation that low phytoplankton biomass occurred at times of highest specific production (Fig. 15) shows that turnover rates are most rapid when phytoplankton population size is reduced. Future studies in St. Georges Bay will be required to quantify seasonal changes in metabolic rates of various sizes of producer and consumer organisms.

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APPENDIX I

Temperature, Salinity, and Density
Dissolved Nutrients
Plant Pigments
Carbon and Nitrogen in Suspended Matter
Phytoplankton Production at Stations 7 and 12

DATE: April 28/77 STATION: 7

SECCHI DEPTH: _____ M

TOTAL SOLAR RADIATION 567 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 311 $cal.cm^{-2}$

INCUBATION TIME 4.75 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/oo	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	4.30						
2.5							
5.0	2.89	28.853	23.02				
10.0	2.24	29.104	23.27				
15.0	0.40	29.242	23.48				
20.0	0.72	29.549	23.71				
25.0	0.22	29.935	24.05				
30.0	1.07	30.794	24.69				
Integral							

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$	DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0		0.14	0.06				
2.5		0.17	0.02	3.95	2.70	1.07	
5.0		0.42	0.00	6.77	7.20	1.06	
10.0		1.08	1.63	6.44	6.12	2.81	
15.0							
20.0		0.43	1.20	1.88	2.53	1.09	
25.0							
30.0		1.62	0.47	3.86	2.72	1.66	
Integral		22.49	26.70	121.66	118.78	46.93	

DATE: April 28, 1977 STATION: 12

SECCHI DEPTH: _____ M

TOTAL SOLAR RADIATION 567 cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION 305 cal.cm^{-2}

INCUBATION TIME 4.75 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/oo	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	3.80	28.441	22.62				
2.5							
5.0	3.13	28.407	22.85				
10.0	1.21	28.604	23.45				
15.0	0.48	29.252	23.62				
20.0	0.82	30.410	24.40				
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3}.day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		0.17	0.06	0	0	13.74		
2.5								
5.0		0.22	0.07	2.61	2.92	1.68		
10.0		0.75	0.14	8.95	4.22	1.17		
15.0		2.16	0.65	5.63		1.85		
Integral		10.68	2.83	71.88		53.22		

DATE: May 16/77 STATION: 7

TOTAL SOLAR RADIATION 224 cal.cm^{-2}.day^{-1}

SECCHI DEPTH: 15 M

SOLAR RADIATION OF INCUBATION 111 cal.cm^{-2}

INCUBATION TIME 3.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	4.30	29.177	23.16				
2.5	3.91	29.167	23.19				
10.0	3.85	29.196	23.22				
15.0	3.67	29.310	23.32				
20.0	2.60	29.691	23.71				
25.0	1.38	29.928	23.98				
30.0	0.67	30.269	24.29				
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL *a* mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		(0.05)	(0.01)	(7.77)	(6.69)	(1.89)		
2.5		0.05	0.01	7.77	6.69	1.89		
5.0		0.08	0.13	9.32	7.86	2.10		
10.0		0.07	0.01	3.00	0.70	2.70		
15.0								
20.0		0.16	0.00	3.00	7.92	2.70		
25.0		0.19	0.38	3.69	2.30	1.78		
Integral		3.56	2.50	135.04	150.51	71.11		

(No measurement, values assumed from 2.5m)

DATE: May 16/77 STATION: 12

SECCHI DEPTH: 15 M

TOTAL SOLAR RADIATION 224 cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION _____ cal.cm^{-2}

INCUBATION TIME _____ hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0							
2.5							
5.0							
10.0							
15.0							
20.0							
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}	DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		0.06	0.00				
2.5		0.08	0.01				
5.0		0.02	0.01				
15.0		0.06	0.11				
20.0		0.06	0.01				
Integral		0.80	0.37				

DATE: May 25, 1977 STATION: 7

SECCHI DEPTH: 22 M (Stn. 9)

TOTAL SOLAR RADIATION 396 cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION _____ cal.cm^{-2}

INCUBATION TIME _____ hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	10.05	29.238	22.48	0.31	0.09	1.01	0.39
2.5							
5.0	6.54	29.306	23.03	0.17	0.18	1.20	0.63
10.0	5.48	29.326	23.16	0.20	0.06	0.32	0.28
15.0	3.64	29.506	23.49	0.00	0.10	0.76	0.29
20.0	2.47	29.745	23.77	0.25	0.05	0.48	0.24
25.0	0.59	30.259	24.29	1.09	0.09	0.68	0.55
30.0	0.75	30.965	24.84	1.88	0.14	2.06	0.67
Integral				12.91	2.98	24.88	12.60

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL α mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}	DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	1.51	0.25	0.00				
2.5							
5.0	1.19	0.15	0.00				
10.0	0.34	0.17	0.04				
15.0	0.71	0.19	0.00				
20.0	0.66	0.49	0.00				
25.0	2.49	0.68	0.00				
30.0	4.39	1.00	0.00				
Integral	41.70	11.53					

DATE: May 25/78 STATION: 12

SECCHI DEPTH: 22 M

TOTAL SOLAR RADIATION 396 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 218 $cal.cm^{-2}$

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/oo	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	8.6	29.190	22.66	0.19	0.03	0.68	0.21
2.5	8.49	29.170					
5.0	7.19	29.229	23.38	0.22	0.03	0.73	0.26
10.0	5.78	29.258	23.08	0.11	0.08	0.51	0.21
15.0	4.41	29.388	23.32	0.21	0.05	1.44	0.29
20.0	2.32	29.983	23.96				
30.0							
Integral				2.65	0.75	11.50	3.60

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	0.59	0.14	0.11	(12.25)	(10.29)	(1.70)		
2.5								
5.0	0.85	0.19	0.06	12.25	10.29	1.70		
10.0	0.50	0.23	0.00	10.59	6.57	4.61		
15.0	0.41	0.07	0.10	4.63	6.22	2.52		
Integral	9.25	2.63	0.83	156.40	125.58	42.10		

DATE: May 30/77 STATION: 7

SECCHI DEPTH: 11 M

TOTAL SOLAR RADIATION 495 cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION 208 cal.cm^{-2}

INCUBATION TIME 1.33 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/$_{oo}$	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	7.2	29.207	22.87	(0.75)	(0.08)	(1.59)	(0.24)
2.5							
5.0	6.55	29.210	22.95	0.75	0.08	1.59	0.24
10.0	6.51	29.210	22.95	0.23	0.03	0.54	0.22
15.0	6.49	29.211	22.96				
20.0	6.33	29.252	22.01	1.20	0.19	3.75	
25.0	6.02	29.288	23.0?				
30.0	5.43	29.310	23.15	0.20	0.08	1.12	0.21
Integral				20.35	3.13	59.08	6.65

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	(1.05)	(0.45)		(9.35)	(9.34)	(1.63)		
2.5								
5.0	1.05	0.45	0.00	9.35	9.34	1.63		
10.0	1.01	0.58	0.00	18.39	8.74	2.03		
15.0								
20.0		0.23	0.00	3.50	0	0.60		
25.0								
30.0	0.55	0.55	0.00	0.74	2.48	1.25		
Integral	26.00	12.78		236.75	148.0	39.20		

DATE: May 30/77 STATION: 12 SECCHI DEPTH: 14 M

TOTAL SOLAR RADIATION 495 $cal.cm^{-2}.day^{-1}$ SOLAR RADIATION OF INCUBATION 208 $cal.cm^{-2}$

INCUBATION TIME 4.33 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	8.0	29.081	22.66	0.41	0.10	1.38	0.34
2.5							
5.0	7.35	29.144	22.79				
10.0	7.03	29.188	22.87	0.51	0.11	1.39	0.19
15.0	6.46	29.257	22.99	0.36	0.06	0.89	0.23
20.0	6.24	29.269	23.03	0.57	0.02	0.54	0.24
Integral				6.78	1.48	19.55	3.70

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	0.85	0.36	0.26	10.29	10.54	4.51		
2.5								
5.0	0.41	0.32	0.16	10.94	9.99	1.63		
10.0	0.66	0.55	0.04	8.45	10.56	1.45		
15.0	1.33	0.01	0.02	11.99	9.62	1.76		
Integral	10.80	5.28	1.70	152.65	153.15	31.08		

DATE: June 7/77 STATION: ____

TOTAL SOLAR RADIATION 86 $cal.cm^{-2}.day^{-1}$

SECCHI DEPTH: 10 M

SOLAR RADIATION OF INCUBATION 33 $cal.cm^{-2}$

INCUBATION TIME 3.5 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	7.60	29.124	22.75	0.12		2.11	0.26
2.5							
5.0	7.50	29.125	22.77	0.21		0.70	0.24
10.0	7.52	29.129	22.76	0.24		1.03	0.25
15.0	6.18	29.336	23.09				
20.0	4.80	29.825	23.63	0.20		1.05	0.38
25.0	3.83	30.522	24.27				
30.0	1.11	30.773	24.67	0.87		1.57	0.70
Integral				9.50		34.85	11.03

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	0.94	1.04	0.23	38.08	35.59	4.33		
2.5								
5.0	1.14	1.04	0.13	19.87	17.48	2.66		
10.0	1.42	1.12	0.00	7.09	8.72	3.06		
15.0								
20.0	1.85	1.89	0.16	4.04	3.96	1.41		
25.0								
30.0	5.42	1.01	4.00	1.11	0.85	2.01		
Integral	64.30	40.15	22.83	293.68	285.63	71.23		

DATE: June 7/77 STATION: 12

SECCHI DEPTH: 10 M

TOTAL SOLAR RADIATION 86 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 33 $cal.cm^{-2}$

INCUBATION TIME 3.5 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	8.00	29.036	22.63	0.24	0.08	0.79	0.27
2.5							
5.0	7.86	29.001	22.62	0.07	0.04	0.59	0.22
10.0	5.82	29.345	23.14	0.20	0.08	0.78	0.30
15.0	5.18	29.949	23.69	0.35	0.08	0.67	0.34
20.0	2.85	30.286	24.17				
25.0							
30.0							
Integral				2.83	1.00	10.50	4.13

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}$ day^{-1}	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	1.65	0.76	0.05	(14.95)	(12.48)	(3.78)		
2.5								
5.0	0.87	0.69	0.09	14.95	12.48	3.78		
10.0	1.14	1.12	0.08	13.86	10.01	2.12		
15.0	1.74	1.21	0.00	4.65	5.46	1.56		
20.0								
25.0								
30.0								
Integral	18.53	13.98	.98	193.05	157.30	42.85		

DATE: June 14/77 STATION: 7

TOTAL SOLAR RADIATION 230 cal.cm^{-2}.day^{-1}

SECCHI DEPTH: 12 M

SOLAR RADIATION OF INCUBATION 110 cal.cm^{-2}

INCUBATION TIME 1.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/oo	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	10.4	29.086	22.30	0.28	0.01	0.38	0.19
2.5							
5.0	10.40	29.128	22.33	0.24	0.01	0.25	0.14
10.0	9.61	29.494	22.75	0.29	0.02	0.52	0.16
15.0	7.95	29.719	23.17	0.34	0.07	0.44	0.17
20.0	6.22	30.233	23.79	0.58	0.05	0.55	0.24
25.0	2.52	30.650	24.49	0.96	0.06	1.19	0.62
30.0	1.40	30.752	24.64	1.08	0.10	3.94	0.64
Integral				15.45	1.55	25.55	8.73

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	0.82	0.29	0.00	19.48	10.50	2.88	145.1	13.9
2.5		0.37	0.00	9.73	13.93	2.45	116.7	11.9
5.0	0.92	0.37	0.00	17.20	15.95	2.65	118.7	13.1
10.0	0.71	0.38	0.00	12.66	14.04	2.20	106.3	14.4
15.0	1.15	0.21	0.00				117.9	21.7
20.0	1.24	0.21	0.00	11.24	11.12	2.29	98.0	16.2
25.0	4.69	0.39	0.00					
30.0	6.48	0.37	0.06	0.92	1.02	1.30	105.0	19.1
Integral	61.80	9.55		312.67	329.48	65.56	3299.25	493.75

DATE: June 14/77 STATION: 12

SECCHI DEPTH: 12 M

TOTAL SOLAR RADIATION _____ cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION 4.0 cal.cm^{-2}

INCUBATION TIME _____ hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	9.80	29.226	22.51	0.43	0.01	0.77	0.26
2.5							
5.0	8.54	29.220	22.60	0.58	0.00	1.86	0.23
10.0	7.79	29.333	22.88	0.39	0.05	0.49	0.86
15.0	6.27	29.530	23.23	0.41	0.07	0.73	0.33
20.0	5.95	29.869	23.54				
25.0							
30.0							
Integral				0.95	0.45	15.50	6.93

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	1.60	0.21	0.00	5.67	5.06	2.64		
2.5		0.23	0.00	11.83	14.97	3.89		
5.0	1.85	0.43	0.00	18.02	16.63	3.14		
10.0	1.78	0.29	0.00	13.73	15.04	3.54		
15.0	1.90	0.59	0.11	9.53	8.80	2.69		
20.0		0.35	0.01					
25.0								
30.0								
Integral	22.63	5.38		196.71	203.31	49.23		

DATE: June 21/77 STATION: 7

SECCHI DEPTH: 17.2 M

TOTAL SOLAR RADIATION 159 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 93 $cal.cm^{-2}$

INCUBATION TIME 4.33 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE $mg\text{-}at\ N.m^{-3}$	NITRITE $mg\text{-}at\ N.m^{-3}$	AMMONIA $mg\text{-}at\ N.m^{-3}$	PHOSPHATE $mg\text{-}at\ P.m^{-3}$
0	11.5	29.106	22.14	0.15	0.04	0.92	0.23
2.5							
5.0	11.50	29.086	22.12	0.20	0.01	0.29	0.28
10.0	10.45	29.166	22.36	0.45	0.02	0.60	0.30
15.0	7.82	29.492	23.01	0.45	0.04	1.16	0.35
20.0	5.61	30.160	23.80	0.23	0.06	0.38	0.40
25.0	2.84	30.463	24.31	0.45	0.07	1.01	0.47
30.0	1.86	30.677	24.55	0.95	0.11	1.54	0.76
Integral				11.65	1.34	23.35	12.38

DEPTH M	SILICATE $mg\text{-}at\ Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	1.17	0.08	0.15	10.90	12.86	1.71	89.5	7.1
2.5		0.06	0.13	10.11	8.59	1.19	44.9	8.4
5.0	1.01	0.06	0.14	9.03	9.08	1.57	44.4	9.2
10.0	1.07	0.10	0.08	3.94	6.19	1.15	42.2	5.7
15.0	2.06	0.10	0.22					
20.0	2.42	0.07	0.31	1.68	1.43	1.06	78.3	14.1
25.0	3.29							
30.0	9.52	0.06	0.23	2.04	1.63	1.06	60.1	8.1
Integral	75.98	2.30	6.01	129.31	130.51	35.53	1790.63	288.63

DATE: June 21/77 STATION: 12

SECCHI DEPTH: 12 M

TOTAL SOLAR RADIATION 159 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 71 $cal.cm^{-2}$

INCUBATION TIME 3.66 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	11.7	28.785	21.86	0.21	0.05	1.23	0.36
2.5							
5.0	11.47	28.838	21.94	0.37	0.05	1.30	0.27
10.0	7.48	29.664	23.18	0.16	0.06	0.39	0.38
15.0	6.42	29.829	23.45	0.13	0.07	0.44	0.45
20.0	5.77	29.959	23.63				
25.0							
30.0							
Integral				3.50	0.85	13.13	5.28

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	1.88	0.18	0.09	11.12	8.06	1.59		
2.5		0.20	0.69	4.08	3.20	23.21		
5.0	1.49	0.17	0.06	0	0	36.53		
10.0	1.78	0.11	0.14	5.69	17.96	1.38		
15.0	2.56	0.08	0.18	0	0	29.38		
20.0								
25.0								
30.0								
Integral	27.45	2.11	3.21	52.55	107.88	277.35		

DATE: June 27/77 STATION: 7

TOTAL SOLAR RADIATION 530 cal.cm^{-2}.day^{-1}

SECCHI DEPTH: _____ M

SOLAR RADIATION OF INCUBATION 150 cal.cm^{-2}

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/oo	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	11.0	29.064	22.03	0.31	0.04	1.00	0.31
2.5				0.27	0.05	1.00	0.28
5.0	11.87	29.084	22.05	0.25	0.04	0.87	0.30
10.0	11.60	29.164	22.16	0.40	0.03	1.68	0.44
15.0							
20.0	6.14	30.014	23.63	0.41	0.06	1.51	0.54
25.0	3.37	30.470	24.27				
30.0	2.18	30.658	24.51				
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	1.46	0.43	0.35	16.55	19.38	1.42		
2.5	2.11	0.39	0.25	9.82	9.81	1.36		
5.0	0.89	0.35	0.37	8.54	8.21	11.36		
10.0	1.56	0.30	0.40	3.10	3.80	2.51		
15.0								
20.0	1.81	0.17	0.40	0.66	1.56	1.47		
25.0								
30.0		0.09	0.35	0	0	1.83		
Integral		7.23	11.20	107.11	123.64	90.45		

DATE: July 5/77 STATION: 7

TOTAL SOLAR RADIATION 600 cal.cm^{-2}.day^{-1}

SECCHI DEPTH: 10 M

SOLAR RADIATION OF INCUBATION 250 cal.cm^{-2}

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/oo	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	15.3	29.030	21.34				
2.5							
5.0	15.15	29.019	21.37				
10.0	12.39	29.242	22.08				
15.0	11.93	29.287	22.20				
20.0	11.90	29.321	22.23				
25.0	8.70	29.715	23.06				
30.0	4.78	30.153	23.89				
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		0.25	0.00	26.18	19.12	3.68		
2.5		0.19	0.02	23.05	20.69	4.75		
5.0		0.13	0.00	22.55	18.68	6.54		
10.0		0.11	0.10	15.02	14.14	2.83		
15.0								
20.0		0.09	0.48	3.55	3.31	2.64		
25.0								
30.0		0.18	0.18	0.19	0.28	2.65		
Integral		3.90	6.50	324.01	286.23	101.88		

DATE: July 5/77 STATION: 12

TOTAL SOLAR RADIATION 600 cal.cm^{-2}.day^{-1}

SECCHI DEPTH: 10 M

SOLAR RADIATION OF INCUBATION 200 cal.cm^{-2}

INCUBATION TIME 3.5 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/$_{oo}$	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	15.4	29.067	21.35				
2.5							
5.0	15.23	29.058					
10.0	14.94	29.133	21.50				
15.0	13.59	29.320	21.91				
20.0	8.10	29.599	23.05				
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		0.08	0.00	29.03	22.40	6.63		
2.5		0.10	0.10	28.80	24.75	8.34		
5.0		0.10	0.19	29.29	25.04	3.27		
10.0		0.14	0.29	17.22	29.77	2.56		
15.0		0.03	0.11	8.45	7.35	1.99		
20.0								
25.0								
30.0								
Integral		1.50	2.69	325.35	351.00	59.18		

DATE: July 12/77 STATION: 7

SECCHI DEPTH: 11 M

TOTAL SOLAR RADIATION 500 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 250 $cal.cm^{-2}$

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	15.0	29.10	21.46				
2.5							
5.0	15.03	29.11	21.46				
10.0	14.89	29.14	21.51				
15.0	14.89	29.09	21.48				
20.0	14.20	29.31	21.79				
25.0	10.00	29.61	22.78				
30.0	7.72	29.98	23.40				

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		0.35	0.30	20.30	19.68	4.91	79.8	9.2
2.5		0.43	0.30	23.26	18.00	3.43		
5.0		0.26	0.45	20.22	24.00	3.26	84.3	9.3
10.0		0.39	0.25	19.11	18.04	1.06	186.0	58.5
15.0								
20.0		0.39	0.35	0.86	3.76	2.89	79.8	11.6
25.0								
30.0		0.22	0.43	0.08	0.37	3.55	59.6	5.7
Integral		10.41	10.34	311.70	334.35	81.54	3112.00	652.75

DATE: July 12/77 STATION: 12

SECCHI DEPTH: 11 M

TOTAL SOLAR RADIATION 500 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 280 $cal.cm^{-2}$

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	15.1	29.26	21.56				
2.5							
5.0	15.04	29.22	21.54				
10.0	15.01	29.29	21.60				
15.0	14.81	29.25	21.61				
20.0	12.90	29.37	22.08				
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL *a* mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		0.13	0.40	11.23	8.54	4.92		
2.5		0.22	0.22	20.42	19.44	1.76		
5.0		0.13	0.30	22.50	22.66	3.01		
10.0		0.26	0.40	12.63	16.60	3.47		
15.0		0.30	0.43	11.51	12.24	3.49		
20.0								
25.0								
30.0								
Integral		3.25	5.25	241.39	257.85	47.91		

DATE: July 18/77 STATION: 7

SECCHI DEPTH: 11 M

TOTAL SOLAR RADIATION 180 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 80 $cal.cm^{-2}$

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	17.9	28.92	20.86	0.64	0.02	2.82	0.31
2.5	-	-		0.56	0.03	4.50	0.45
5.0	17.75	28.88	20.62	0.07	0.06	0.52	0.29
10.0	16.51	29.00	21.05	0.62	0.04	2.99	0.32
15.0	15.80	29.10	21.29				
20.0	12.96	29.14	21.90	0.41	0.04	3.66	0.42
25.0							
30.0				0.97	0.07	2.61	0.59
Integral				16.06	1.38	88.80	12.15

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}.day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	1.19	0.39	0.35	32.30	31.73	9.70		
2.5	1.83	0.43	0.19	16.92	16.84	14.33		
5.0	1.51	0.43	0.19	15.45	12.70	8.00		
10.0	1.12	0.35	0.25	7.50	8.65	7.47		
15.0								
20.0	1.92	0.56	0.25	2.15	2.68	6.53		
25.0								
30.0	5.47	0.22	0.40	0	0.19	7.41		
Integral	66.68	12.50	8.00	218.36	221.94	236.33		

DATE: July 18/77 STATION: 12

SECCHI DEPTH: 9 M

TOTAL SOLAR RADIATION 180 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 90 $cal.cm^{-2}$

INCUBATION TIME 1.5 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	17.6	28.68	20.57	0.51	0.04	3.19	0.34
2.5	-	-					
5.0	17.48	28.69	20.60	0.19	0.02	0.80	0.31
10.0	-	-		0.45	0.05	2.58	0.35
15.0	15.34	29.04	21.35	0.26	0.01	2.72	0.37
20.0	13.50	29.23	21.87				
25.0							
30.0							
Integral				5.13	0.48	32.13	5.08

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	0.82	0.73	0.52	44.52	40.23	7.31		
2.5		0.56	0.55	40.76	39.61	11.84		
5.0	0.57	0.82	0.26	34.54	32.90	11.51		
10.0	1.67	0.43	0.47	12.72	13.00	11.36		
15.0		0.48	0.60	7.36	7.99	8.81		
20.0								
25.0								
30.0								
Integral		8.74	6.85	369.08	357.66	160.73		

DATE: July 26/77 STATION: 7

TOTAL SOLAR RADIATION 590 cal.cm^{-2}.day^{-1}

SECCHI DEPTH: 8 M

SOLAR RADIATION OF INCUBATION 300 cal.cm^{-2}

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	17.4	28.78	20.69	0.31	0.04	4.20	
2.5	-	-		0.15	0.04	2.76	0.17
5.0	-	-		0.19	0.01	7.49	0.19
10.0	17.20	28.66	20.64	0.26	0.03	3.09	0.21
15.0	17.16	28.68	20.67				
20.0	13.11	29.24	21.94	0.27	0.06	2.63	0.43
25.0	11.38	29.41	22.39				
30.0	8.21	29.80	23.19	2.17	0.07	4.61	0.96
Integral				16.98	1.36	112.76	12.03

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	1.67	0.39	0.00	36.46	37.46	3.68	106.5	9.9
2.5	1.37	0.31	0.00	29.35	29.90	2.78		
5.0	1.81	0.07	0.09	24.67	24.23	2.80	94.1	16.6
10.0	1.53	0.16	0.08	0	11.14	4.15	89.0	9.4
15.0								
20.0	2.93	0.23	0.16	3.89	3.72	2.97	76.1	9.1
25.0								
30.0	13.21	0.26	0.00	1.01	0.35	1.85	839	4.4
Integral	119.13	6.33		255.41	334.94	92.13	2584.75	291.25

DATE: July 26/77 STATION: 13

TOTAL SOLAR RADIATION 590 cal.cm^{-2}.day^{-1}

SECCHI DEPTH: 8 M

SOLAR RADIATION OF INCUBATION 320 cal.cm^{-2}

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	17.5	28.75	20.64	0.34	0.06	3.37	0.27
2.5	-	-					
5.0	17.24	28.71	20.67	0.21	0.02	2.36	0.24
10.0	17.05	28.76	20.75	0.18	0.02	1.71	0.34
15.0	16.83	28.83	20.86	0.28	0.04	4.12	0.28
20.0							
25.0							
30.0							
Integral				3.50	0.45	39.08	4.28

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	2.15	0.34	0.00	44.07	23.27	7.65		
2.5		0.23	0.06	32.40	31.47	5.00		
5.0		0.22	0.01	33.31	30.78	5.88		
10.0	1.79	0.22	0.02	16.57	16.62	3.53		
15.0	1.42	0.14	0.14	6.10	5.96	3.18		
20.0								
25.0								
30.0								
Integral	27.73	3.28	0.64	359.10	321.19	69.71		

DATE: Aug. 2/77 STATION: 7

SECCHI DEPTH: 0 M

TOTAL SOLAR RADIATION 700 cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION _____ cal.cm^{-2}

INCUBATION TIME _____ hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0							
2.5							
5.0							
10.0							
15.0							
20.0							
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL *a* mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}	DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		0.23	0.06				
2.5							
5.0		0.23	0.00				
10.0		0.18	0.18				
15.0							
20.0		0.15	0.27				
25.0							
30.0		0.05	0.07				
Integral		4.63	4.55				

DATE: Aug. 9/77 STATION: 7

TOTAL SOLAR RADIATION 459 $cal.cm^{-2}.day^{-1}$

SECCHI DEPTH: 9 M

SOLAR RADIATION OF INCUBATION 208 $cal.cm^{-2}$

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/oo	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	20.8	28.56	19.69				
2.5							
5.0	20.78	28.55	19.69				
10.0	20.58	28.56	19.74				
15.0	18.82	28.75	20.33				
20.0	16.01	28.87	21.06				
25.0	9.50	29.56	22.82				
30.0	6.38	30.16	23.71				
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL *a* mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}	DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		0.35	0.30	36.28 35.51	6.46		
2.5		0.43	0.37	32.34 32.33	6.78		
5.0		0.48	0.27	19.46 28.45	7.56		
10.0		0.90	0.08	25.77 29.32	9.39		
15.0							
20.0		0.69	0.59	6.37 7.44	8.06		
25.0							
30.0		0.17	0.30	0.06 0.34	5.65		
Integral		18.49	10.31	456.47 527.90	232.65		

* Extrapolated from bathythermograph profile.

DATE: Aug 9/77 STATION: 12

SECCHI DEPTH: 9 M

TOTAL SOLAR RADIATION 459 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 246 $cal.cm^{-2}$

INCUBATION TIME 4.5 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	21.0	28.42	19.53				
2.5							
5.0	20.76	28.43	19.60				
10.0	19.13	28.60	20.14				
15.0	-	28.75	-				
20.0	13.44	29.23	21.87				
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL *a* $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}.day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0		0.43	0.17	34.99	33.45	5.42		
2.5		1.73	2.00	62.06	33.41	4.12		
5.0		0.99	0.16	40.17	40.95	4.28		
10.0		0.39	0.40	22.30	22.18	6.97		
15.0		0.52	0.14	3.65	4.75	5.39		
20.0								
25.0								
30.0								
Integral		11.83	8.16	470.15	401.68	81.45		

DATE: Aug. 15/77 STATION: 7 SECCHI DEPTH: 11 M

TOTAL SOLAR RADIATION 571 $cal.cm^{-2}.day^{-1}$ SOLAR RADIATION OF INCUBATION 283 $cal.cm^{-2}$

INCUBATION TIME 4.5 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	20.2	28.58	19.85	0.31	0.03	3.25	0.22
2.5				0.32	0.03	6.19	0.33
5.0	20.19	28.54	19.82	0.26	0.05	3.36	0.23
10.0	20.14	28.56	19.85	0.22	0.04	2.27	0.24
15.0	20.06	28.53	19.86				
20.0	19.11	28.57	20.12	0.51	0.07	3.82	0.49
25.0	12.15	29.33	22.19				
30.0	5.15	30.28	23.94	2.25	0.21	7.35	1.03
Integral				20.16	2.35	124.11	13.91

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL *a* $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	1.72	0.86	0.00	42.61	39.39	6.24		
2.5	1.58	0.78	0.01	40.02	39.31	9.64		
5.0	1.33	0.80	0.01	39.87	28.75	5.72		
10.0		0.95	0.03	31.99	28.93	6.37		
15.0								
20.0	4.03	1.21	0.00	0	0	4.98		
25.0								
30.0	19.61	0.32	0.00	8.13	8.38	4.39		
Integral	166.16	26.85		583.40	514.20	172.88		

* Extrapolated from bathythermograph profile

DATE: Aug. 15/77 STATION: 12

SECCHI DEPTH: 9 M

TOTAL SOLAR RADIATION 571 cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION 285 cal.cm^{-2}

INCUBATION TIME 1.5 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/$_{oo}$	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	20.1	28.58	19.88	0.59	0.04	1.73	0.43
2.5	-	-	-	0.26	0.04	2.17	0.35
5.0	20.23	28.54	19.82				
10.0	19.89	28.54	19.90				
15.0	19.78	28.65	20.01	0.34	0.06	1.79	0.41
20.0	14.32	29.01	21.53				
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}	DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	1.95	0.63	1.47	196.70 187.20	8.23		
2.5	2.11	0.95	0.05	28.20 28.89	6.96		
5.0		0.86	0.07	36.09 36.64	5.82		
10.0		0.91	0.07	19.25 21.99	17.71		
15.0	3.46	1.08	0.08	13.68 15.22	4.66		
20.0							
25.0							
30.0							
Integral	39.89	13.64	2.78	582.16 591.63	149.71		

DATE: Sept. 1/77 STATION: 2

TOTAL SOLAR RADIATION 426 cal.cm^{-2}.day^{-1}

SECCHI DEPTH: _____ M

SOLAR RADIATION OF INCUBATION 221 cal.cm^{-2}

INCUBATION TIME 3.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/oo	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	19.0				0.04		0.27
2.5	19.0				0.04		0.31
5.0	19.0				0.01		0.25
10.0	19.0				0.03		0.28
15.0							
20.0	15.5				0.12		0.64
25.0							
30.0	8.5				0.32		0.91
Integral					3.21		15.33

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	1.30	0.56	0.00	32.32	32.27	7.14		
2.5	0.96	0.61	0.00	19.53	21.62	3.19		
5.0	1.33	0.61	0.09	36.57	32.56	4.29		
10.0	1.40	0.61	0.04	29.00	29.98	3.54		
15.0								
20.0	6.86	0.65	0.16	0	0	4.33		
25.0								
30.0	14.37	0.30	0.15	2.26	1.94	4.85		
Integral	159.96	17.09	2.44	455.16	451.04	127.09		

DATE: Sept. 6/77 STATION: 7

SECCHI DEPTH: _____ M

TOTAL SOLAR RADIATION 200 cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION 104 cal.cm^{-2}

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/..	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	19.3	28.344	19.90				
2.5							
5.0	19.31	28.343	19.90				
10.0	19.31	28.340	19.90				
15.0	19.14	28.386	19.98				
20.0	15.73	28.830	21.10				
25.0	9.46	29.602	22.85				
30.0	4.92	30.532	24.17				
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL α mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		0.61	0.00	39.87	44.46	7.25		
2.5								
5.0		0.43	0.22	25.11	27.15	11.67		
10.0		0.48	0.07	13.31	14.64	5.47		
15.0								
20.0		0.35	0.15	3.76	2.58	3.97		
25.0								
30.0		0.22	0.02	3.57	0.82	1.56		
Integral		11.88	3.23	380.50	386.60	164.95		

DATE: Sept. 13/77 STATION: 12

SECCHI DEPTH: 7.5 M

TOTAL SOLAR RADIATION 266 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 180 $cal.cm^{-2}$

INCUBATION TIME 5.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0							
2.5							
5.0							
10.0							
15.0							
20.0							
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL *a* $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0		1.02	0.00	34.55	35.49	3.37		
2.5								
5.0		1.02	0.00	25.30	26.27	2.64		
10.0		1.36	0.00	14.97	13.67	3.15		
15.0		1.13	0.00	3.05	3.65	2.18		
20.0								
25.0								
30.0								
Integral		17.28		295.35	297.55	42.83		

DATE: Sept. 19/77 STATION: 7

SECCHI DEPTH: 5 M

TOTAL SOLAR RADIATION _____ cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION _____ cal.cm^{-2}

INCUBATION TIME _____ hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	16.7						
2.5							
5.0	16.28						
10.0	16.12						
15.0	15.92						
20.0							
25.0	11.24						
30.0							
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}	DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0							
2.5						273.0	32.7
5.0							
10.0						196.4	21.3
15.0						143.3	15.9
20.0						91.5	11.4
25.0						107.7	9.9
30.0							
Integral						87.2	9.5
						4082.3	446.5

DATE: Sept. 28/77 STATION: 7

SECCHI DEPTH: 9 M

TOTAL SOLAR RADIATION 411 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 216 $cal.cm^{-2}$

INCUBATION TIME 1.33 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	15.5			0.21	0.00	0.17	0.35
2.5				0.08	0.10	0.26	0.39
5.0	14.89			0.06	0.01	0.22	0.33
10.0	14.74			0.17		0.03	0.29
15.0	14.74						
20.0	14.79			0.11	0.04	0.77	0.31
25.0	14.65						
30.0	9.75			0.86	0.18	2.35	0.85
Integral				7.36	1.74	21.36	12.18

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	2.08	1.25	0.64	66.98	61.85	63.07	98.1	11.5
2.5	2.20	0.91	0.25	60.29	63.66	62.85		
5.0	2.31	1.25	0.57	64.97	57.18	62.95	90.5	10.3
10.0	1.85	0.68	1.12	30.59	27.43	55.17	84.5	11.0
15.0								
20.0	2.01	1.25	0.44	1.74	8.73	63.79	80.4	12.0
25.0								
30.0	13.68	0.39	0.32	0.43	1.15	61.34	33.6	3.5
Integral	119.14	28.08	17.96	727.06	633.01	1830.40	2303.50	300.25

DATE: Sept. 28/77 STATION: 12

SECCHI DEPTH: 8 M

TOTAL SOLAR RADIATION 411 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 282 $cal.cm^{-2}$

INCUBATION TIME 5.11 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	14.75			0.14	0.07	0.34	0.35
2.5				0.23	0.08	0.35	0.11
5.0	14.80			0.23	0.01	0.51	0.36
10.0	14.68			0.17	0.05	0.37	0.31
15.0	14.70			0.15	0.05	0.58	0.32
20.0							
25.0							
30.0							
Integral				2.84	0.67	6.51	5.24

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	2.65	1.47	0.37	82.45	80.52	55.63		
2.5	3.66	1.70	0.90	91.49	86.94	52.23		
5.0	3.25	1.47	0.83	61.85	91.34	50.87		
10.0	2.86	1.48	0.97	32.63	32.32	45.71		
15.0	3.16	2.50	0.00	11.31	7.47	48.39		
20.0								
25.0								
30.0								
Integral	46.85	25.25	10.68	755.08	840.80	740.40		

DATE: Oct. 3/77 STATION: 7

TOTAL SOLAR RADIATION 207 cal.cm^{-2}.day^{-1}

SECCHI DEPTH: _____ M

SOLAR RADIATION OF INCUBATION _____ cal.cm^{-2}

INCUBATION TIME _____ hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0							
2.5							
5.0							
10.0							
15.0							
20.0							
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}	DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0							
2.5						181.8	20.4
5.0							
10.0						207.2	10.8
15.0						251.7	10.5
20.0							
25.0						236.8	9.3
30.0							
Integral						234.5 7368.8	9.4 323.8

DATE: Oct. 18/77 STATION: 7

SECCHI DEPTH: 9 M

TOTAL SOLAR RADIATION 56 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 30 $cal.cm^{-2}$

INCUBATION TIME 4 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0							
2.5							
5.0							
10.0							
15.0							
20.0							
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0		3.89	0.00	41.58	44.26	49.09	120.7	16.0
2.5								
5.0		1.73	0.00	32.47	24.40	52.07	104.2	12.8
10.0		1.30	0.39	8.76	9.31	58.36	105.1	14.7
15.0								
20.0		1.01	0.40	0.22	1.18	60.23	109.7	16.4
25.0								
30.0		0.54	0.31	0.41	1.93	50.52	70.9	10.8
Integral		40.93	9.45	336.25	323.93	1675.68	3062.50	432.3

DATE: Oct. 18/77 STATION: 12

SECCHI DEPTH: 8 M

TOTAL SOLAR RADIATION 56 cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION 30 cal·cm^{-2}

INCUBATION TIME 1 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/$_{oo}$	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0							
2.5							
5.0							
10.0							
15.0							
20.0							
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at Si. $^{-3}$	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		1.73	0.72	46.78	51.13	56.60		
2.5								
5.0		1.30	0.22	24.26	22.92	50.17		
10.0		1.30	0.75	4.54	4.86	66.80		
15.0		1.30	0.39	12.37	4.35	57.41		
20.0								
25.0								
30.0								
Integral		20.58	7.53	291.88	277.60	869.88		

DATE: Oct. 25/77 STATION: 7

SECCHI DEPTH: 4 M

TOTAL SOLAR RADIATION _____ $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION _____ $cal.cm^{-2}$

INCUBATION TIME _____ hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	11.3	28.544	21.73	0.70	0.16	1.14	0.59
2.5							
5.0	11.2	28.537	21.75	0.47	0.15	0.91	0.60
10.0	11.2	28.532	21.74	0.56	0.11	0.94	0.51
15.0	11.23	28.552	21.75	0.86	0.08	0.87	0.50
20.0	11.22	28.543	21.75	0.41	0.12	0.91	0.53
25.0	11.23	28.639	21.82	0.52	0.11	1.06	0.49
30.0	11.27	28.672	21.84	0.49	0.12	0.87	0.50
Integral				17.08	3.55	28.48	15.88

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$	DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	5.06	1.09	0.39			188.0	18.1
2.5							
5.0	5.29	1.09	0.51			97.7	11.8
10.0	5.26	1.01	0.38			120.9	13.0
15.0	5.33	0.77	0.33			99.2	14.6
20.0	5.35	0.85	0.36			137.0	18.3
25.0	7.07	0.66	0.39			93.9	11.9
30.0	5.35	0.68	0.25			114.8	12.6
Integral	167.53	26.33	11.45			3500.5	429.8

DATE: Oct. 25/77 STATION: 12

SECCHI DEPTH: 5.8 M

TOTAL SOLAR RADIATION _____ cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION _____ cal.cm^{-2}

INCUBATION TIME _____ hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	10.9	28.572	21.82	0.00	0.12	0.87	0.18
2.5							
5.0	10.06	28.566	21.96	0.70	0.12	2.18	0.55
10.0	10.91	28.590	21.84	1.30	0.08	1.10	0.57
15.0	10.94	28.662	21.89	0.82	0.14	1.09	0.61
20.0	10.62	28.674	21.95				
25.0							
30.0							
Integral				12.50	1.65	21.30	8.33

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}	DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	4.65	1.09	0.46				
2.5							
5.0	5.61	1.09	0.38				
10.0	4.65	0.87	0.30				
15.0	5.74	0.77	0.25				
20.0							
25.0							
30.0							
Integral	77.28	14.45	5.18				

DATE: Oct. 31/77 STATION: 7

SECCHI DEPTH: 8 M

TOTAL SOLAR RADIATION 205 cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION 144 cal.cm^{-2}

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	10.4	28.690	22.00	0.84	0.11	0.71	0.58
2.5							
5.0	10.33	28.691	22.01	0.86	0.07	0.74	0.55
10.0	10.34	28.691	22.01	0.91	0.16	0.86	0.56
15.0	10.37	28.686	22.00				
20.0	10.38	28.683	21.99	0.95	0.09	0.74	0.41
25.0	10.36	28.688	22.00				
30.0	10.37	28.689	22.00	1.00	0.10	1.07	0.56
Integral				27.38	3.23	24.68	15.30

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL *a* mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	5.93	1.20	0.19	18.26	15.36	56.53	100.8	10.9
2.5								
5.0	5.74	1.20	0.14	12.02	11.00	22.09	73.2	6.7
10.0	5.67	0.99	0.09	13.09	3.84	18.82	72.6	5.5
15.0								
20.0	4.28	0.97	0.32	1.10	0.91	19.74	106.9	6.9
25.0								
30.0	6.06	0.68	0.27	0	0.64	20.08	69.1	11.6
Integral	159.15	29.53	6.40	214.93	134.50	690.58	2577.0	229.0

DATE: Oct. 31/77 STATION: 12

SECCHI DEPTH: _____ M

TOTAL SOLAR RADIATION 205 $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION 144 $cal.cm^{-2}$

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	10.5	28.655	21.95	0.90	0.10	0.97	0.60
2.5							
5.0	10.49	28.647	21.95	0.80	0.17	0.84	0.55
10.0	10.50	28.645	21.95	0.80	0.12	0.77	0.51
15.0	10.51	28.645	21.95	0.76	0.12	0.78	0.57
20.0	10.49	28.656	21.96				
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$		DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	5.33	0.88	0.22	20.02	20.89	52.36		
2.5								
5.0	5.83	0.88	0.17	14.87	12.58	46.40		
10.0	5.79	0.58	0.42	1.49	5.00	64.04		
15.0	5.58	0.97	0.36	0.93	0	51.24		
20.0								
25.0								
30.0								
Integral	85.38	11.93	4.40	134.18	140.13	811.20		

DATE: Nov. 14/77 STATION: 7

SECCHI DEPTH: 12 M

TOTAL SOLAR RADIATION 198 cal.cm^{-2}.day^{-1}

SOLAR RADIATION OF INCUBATION 120 cal.cm^{-2}

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/$_{oo}$	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	9.2	28.676	22.18	1.38		1.34	1.10
2.5							0.30
5.0	9.34	28.663	22.14	0.24			0.41
10.0	9.39	28.663	22.13	3.11		1.14	0.50
15.0	9.41	28.667	22.14	1.28		1.02	0.32
20.0	9.43	28.662	22.13	1.32		2.58	0.32
25.0	9.49	28.689	22.14	0.98			0.24
30.0	9.23	29.022	22.44	1.11		4.04	12.60
Integral				40.88		59.90	

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}	DARK UPTAKE mg.C.m^{-3} day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0	6.97	0.88	0.02	15.93 14.53	19.24	198.3	26.3
2.5							25.5
5.0	1.66	0.99	0.00	9.76 14.15	25.15	84.9	24.3
10.0	4.52	1.09	0.00	5.06 5.28	30.63	91.9	
15.0	6.87						25.4
20.0	5.39	1.02	0.00	3.92 5.64	19.13	75.2	
25.0	4.82						25.8
30.0	5.66	0.39	0.11	0 0	29.16		258.5
Integral	147.88	27.48	1.95	165.78 203.08	740.68		

* Nitrate & Nitrite

DATE: Nov. 14/77 STATION: 12

TOTAL SOLAR RADIATION 198 cal.cm^{-2}.day^{-1}

SECCHI DEPTH: 11 M

SOLAR RADIATION OF INCUBATION 120 cal.cm^{-2}

INCUBATION TIME 4.0 hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at N.m^{-3}	NITRITE mg-at N.m^{-3}	AMMONIA mg-at N.m^{-3}	PHOSPHATE mg-at P.m^{-3}
0	9.3	28.543	22.05				
2.5							
5.0	9.25	28.552	22.07				
10.0	9.33	28.548	22.06				
15.0	9.30	28.548	22.06				
20.0	9.45	28.292	22.07				
25.0							
30.0							
Integral							

DEPTH M	SILICATE mg-at Si.m^{-3}	CHLOROPHYLL a mg.m^{-3}	PHEOPIGMENTS mg.m^{-3}	PRIMARY PROD. mg.C.m^{-3}.day^{-1}		DARK UPTAKE mg.C.m^{-3}.day^{-1}	PARTICULATE CARBON mg.C.m^{-3}	PARTICULATE NITROGEN mg.N.m^{-3}
0		0.74	0.25	11.51	11.20	21.64		
2.5		1.65	0.00	24.90	9.57	21.77		
5.0		1.36	0.00	21.86	16.49	26.53		
10.0		1.27	0.12	14.59	15.13	25.55		
15.0		1.36	0.00	2.94	7.08	26.16		
20.0								
25.0								
30.0								
Integral		19.90	1.85	238.91	193.11	374.11		

DATE: Dec. 21/77 STATION: 7

SECCHI DEPTH: _____ M

TOTAL SOLAR RADIATION _____ $cal.cm^{-2}.day^{-1}$

SOLAR RADIATION OF INCUBATION _____ $cal.cm^{-2}$

INCUBATION TIME _____ hr.

DEPTH M	TEMPERATURE °C	SALINITY °/₀₀	DENSITY σ_t	NITRATE mg-at $N.m^{-3}$	NITRITE mg-at $N.m^{-3}$	AMMONIA mg-at $N.m^{-3}$	PHOSPHATE mg-at $P.m^{-3}$
0	1.3	27.94	22.39	1.40	0.12	1.07	0.30
2.5	1.0						
5.0	1.0	27.94	22.41	1.08	0.01	0.88	0.17
10.0	1.0	27.98	22.44	1.47	0.13	0.99	0.27
20.0	1.2	28.07	22.50	1.75	0.05	0.61	0.30
25.0	1.3			1.72	0.10	0.91	0.28
30.0	2.6						
Integral							

DEPTH M	SILICATE mg-at $Si.m^{-3}$	CHLOROPHYLL a $mg.m^{-3}$	PHEOPIGMENTS $mg.m^{-3}$	PRIMARY PROD. $mg.C.m^{-3}.day^{-1}$	DARK UPTAKE $mg.C.m^{-3}\ day^{-1}$	PARTICULATE CARBON $mg.C.m^{-3}$	PARTICULATE NITROGEN $mg.N.m^{-3}$
0	6.71	1.45	0.54			187.1	17.0
2.5							
5.0	4.68	1.65	0.59			289.7	20.9
10.0	6.71	1.65	1.06			293.8	26.1
15.0	7.30	1.07	0.65			485.7	74.0
20.0	7.60	1.46	0.11			215.5	26.2
25.0							
30.0							
Integral							

APPENDIX II

Dissolved Nutrients
Plant Pigments
Phytoplankton Production at Crystal Cliffs Station

CRYSTAL CLIFFS

DATE	SOLAR RADIATION Cal cm^{-2}. day^{-1}	NITRATE mg-at N. m^{-3}	NITRITE mg-at N. m^{-3}	AMMONIA mg-at N. m^{-3}	PHOSPHATE mg-at P. m^{-3}	SILICATE mg-at Si. m^{-3}	CHLOROPHYLLa mg . m^{-3}	PHEOPIGMENTS mg. m^{-3}	PRIMARY PRODUCTION mg C. m^{-3} day^{-1}		DARK UPTAKE mg C. m^{-3} day^{-1}
April 7							0.06	0			
May 5	646						0.67	0.17			
May 16	224						0.13	0.46	17.90	16.94	12.64
May 25	396	0.33	0.12	0.60	0.76				144.94	84.23	5.12
June 8							1.25	0.51			
June 13							1.38	0			
June 14	230	0.18	0.10	0.46	0.18	4.00	0.97	0.42			
June 15							0.58	0.88			
June 16							0.50	0.24			
June 20							0.45	0.32			
June 21	150	0.23	-	0.95	0.27	3.30	0.52	0	23.99	22.09	2.56
June 22							0.45	0.76			
June 23							0.68	0.82			
June 27	530	0.43	0.08	1.62	0.41	3.84	0.90	1.22	28.88	20.40	2.12

CRYSTAL CLIFFS

DATE	SOLAR RADIATION Cal cm^{-2}. day^{-1}	NITRATE mg-at N. m^{-3}	NITRITE mg-at N. m^{-3}	AMMONIA mg-at N. m^{-3}	PHOSPHATE mg-at P. m^{-3}	SILICATE mg-at Si. m^{-3}	CHLOROPHYLL a mg . m^{-3}	PHEOPIGMENTS mg. m^{-3}	PRIMARY PRODUCTION mg C. m^{-3} day^{-1}		DARK UPTAKE mg C. m^{-3} cav.
July 4							0.23	1.73			
July 5							0.10	0.35			
July 12	500								28.65	[illegible]	5.57
July 13							0.35	1.04			
July 14							0.39	0.53			
July 18	180	0.97	0.07	2.61	0.59		0.45	1.79	23.99	25.54	9.40
July 26		0.92	0.07	1.25	0.26	2.59					
August 3							0.32	0.87			
August 4											
August 9							0.57	1.06			
August 15							0.76	0.19			
Sept. 1	426		0.07		0.44	5.45	0.48	0.12	17.82	18.72	4.38
Sept. 6	200						1.73	0	72.97	65.15	8.47

CRYSTAL CLIFFS

DATE	SOLAR RADIATION Cal cm^{-2}. day^{-1}	NITRATE mg-at N. m^{-3}	NITRITE mg-at N. m^{-3}	AMMONIA mg-at N. m^{-3}	PHOSPHATE mg-at P. m^{-3}	SILICATE mg-at Si. m^{-3}	CHLOROPHYLLa mg . m^{-3}	PHEOPIGMENTS mg. m^{-3}	PRIMARY PRODUCTION mg C. m^{-3} day^{-1}		DARK UPTAKE mg C. m^{-3} day^{-1}
Sept. 13	266						1.73	2.08	38.50	38.43	0.55
Sept. 20											
Sept. 26							1.47	0.77			
Sept. 27							2.09	3.22			
Sept. 28							2.53	3.23	37.17	34.33	59.41
Oct. 4	207						2.27	1.73	58.36	64.20	61.89
Oct. 25		0.81	0.10	1.20	0.08	5.35	8.21	8.96			
Oct. 31	205						1.17	1.84	10.34	17.41	52.03

APPENDIX III

Plant Pigments
Surface Temperature and Salinity along the
Ballantynes Cove Transect

TRANSECT - SGB

DATE: April 28, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14		0.15	0.14	4.3	28.51	
13		0.75	0.00			
12		0.17	0.06	3.8	28.44	
11		0.24	0.01			
10		0.22	0.04			
9		0.20	0.06			
8						
7	14.5	0.14	0.06	4.3		
$\bar{X}$		0.27	0.05	4.1	28.48	
σ		0.21	0.04	0.3	0.06	
C.V.(%)		77.8	76.9	7.1	0.2	

Blanks indicate that samples were not collected.

0 values for measures of pheopigments indicate that negative values were obtained in calculation of concentrations.

C.V. % $(\sigma/\bar{X}) \cdot 100$

TRANSECT - SGB

DATE: May 16, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.L^{-1}$	PHEOPIGMENTS $\mu g.L^{-1}$	TEMP. °C	SALINITY °/oo
14		0.06	0.003	4.5	29.13
13		0.02	0.008		
12	15	0.06	0.003	4.4	29.24
11					
10		0.06	0.007	4.8	29.29
9		0.08	0.006		
8	15	0.07	0.007	4.3	29.18
7					
$\bar{X}$		0.06	0.006	4.5	29.24
σ		0.02	0.002	0.2	0.06
%		33.3	33.3	4.9	0.2

TRANSECT - SGB

DATE: May 25, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL *a* $\mu g.\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14		0.20	0	8.9	29.20	
13		0.24	0			
12		0.14	0	8.6	29.19	
11		0.14	0.017			
10		0.16	0	9.1	29.07	
9	22	0.13	0			
8		0.16	0.003			
7		0.25	0.001	10.05	29.24	
$\bar{X}$		0.18	0.003	9.2	29.18	
σ		0.05	0.006	0.6	0.07	
%		27.3	50.0	6.5	0.2	

TRANSECT - SGB

DATE: May 30, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14		0.62	0.06			
13		0.97	0			
12		0.36	0.26	8.0	29.08	
11		0.55	0			
10		0.71	0	7.7	29.15	
9		0.71	0			
8		0.58	0			
7	14	0.45	0	7.2	29.21	
$\bar{X}$		0.64	0.04	7.6	29.15	
σ		0.19	0.09	0.4	0.07	
%		29.4	44.4	5.3	0.2	

TRANSECT - SGB

DATE: June 7, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/oo
14		1.28	0	7.5	28.43
13		1.00	0		
12		0.76	0	8.0	29.04
11		0.69	0.09		
10		0.61	0.34	7.9	29.04
9		0.95	0.03		
8	10	0.78	0.13		
7		1.04	0.23	7.6	29.12
$\bar{X}$		0.89	0.10	7.8	28.91
σ		0.22	0.13	0.2	0.32
%		24.9	122.3	2.6	1.1

TRANSECT - SGB

DATE: June 14, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL *a* $\mu g\ L^{-1}$	PHEOPIGMENTS $\mu g\ L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14	10.0	0.25	0	9.27	29.39	
13	10.5	0.30	0			
12	11.0	0.21	0	9.8	29.23	
11	10.5	0.25	0			
10	14.0	0.18	0	10.9	29.09	
9	14.5	0.14	0			
8	14.5	0.15	0			
7	14.0	0.29	0	10.4	29.08	
$\bar{X}$		0.22	0	10.09	29.20	
σ		0.06		0.71	0.15	
%		26.8	100	7.0	0.5	

TRANSECT - SGB

DATE: June 20, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/oo
14	11.6	0.35	0.23	11.4	28.90
13	11.6	0.30	0.20		
12		0.46	0.26	12.7	28.79
11	11.6	0.44	0.12		
10	15.4	0.29	0.39	11.95	28.89
9	15.3	0.49	0		
8	16.7				
7	17.2	0.97	0.55	11.50	29.11
$\bar{X}$		0.47	0.25	11.89	28.92
σ		0.23	0.18	0.59	0.13
%		49.2	71.5	5.0	0.4

TRANSECT - SGB

DATE: June 21, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.L^{-1}$	PHEOPIGMENTS $\mu g.L^{-1}$	TEMP. °C	SALINITY °/oo	
14		0.24	0.08	11.4		
13		0.17	0.11			
12	12	0.18	0.09	11.7	28.78	
11		0.07	0.17			
10		0.11	0.13	11.95	28.89	
9		0.07	0.17			
8		0.20	0.06			
7		0.08	0.15	11.5	29.11	
$\bar{X}$		0.13	0.12	11.6	28.93	
σ		0.06	0.04	.25	.16	
%		48.8	35.8	2.1	0.6	

TRANSECT - SGB

DATE: June 27, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.L^{-1}$	PHEOPIGMENTS $\mu g.L^{-1}$	TEMP. °C	SALINITY °/oo	
14						
13						
12						
11						
10		0.26	0.45			
9						
8		0.35	0.42			
7		0.43	0.35	11.9	29.06	
$\bar{X}$		0.35	0.41			
σ		0.09	0.06			
		25.1	13.5			

TRANSECT - SGB

DATE: July 5, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.L^{-1}$	PHEOPIGMENTS $\mu g.L^{-1}$	TEMP. °C	SALINITY °/oo
14	11			15.0	29.01
13	11				
12	10	0.08	0	15.4	29.07
11	11	0.19	0.02		
10	10	0.10	0.14	15.8	29.13
9	10	0.13	0		
8	10	0.16	0		
7	10	0.25	0	15.3	29.03
$\bar{X}$		0.15	0.03	15.4	29.06
σ		0.06	0.06	0.33	0.05
%		41.7	211.5	2.1	1.7

TRANSECT - SGB

DATE: July 12, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL *a* $\mu g\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/oo	
14	10	0.39	0.35	18.3	29.1	
13	12					
12	11	0.13	0.40	19.2	29.3	
11	11	0.26	0.40			
10	11	0.39	0.25	19.3	29.2	
9	11	0.26	0.38			
8	11	0.22	0.35			
7	11	0.35	0.30	19.3	29.2	
$\bar{X}$		0.28	0.35	19.03	29.2	
σ		0.10	0.06	0.49	0.1	
%		33.8	16.8	2.6	0.3	

TRANSECT - SGB

DATE: July 18, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.L^{-1}$	PHEOPIGMENTS $\mu g.L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14	8	0.65	0.57	17.3	28.72	
13	8	1.04	0.15			
12	9	0.73	0.52	17.6	28.68	
11	8	0.56	0.29			
10	8	0.78	0.06	17.9	28.94	
9	11	0.52	0.24			
8	10	0.48	0.07			
7	11	0.39	0.35	17.9	28.92	
$\bar{X}$		0.64	0.28	17.7	28.82	
σ		0.21	0.19	.29	0.13	
%		32.0	68.3	1.6	0.5	

TRANSECT - SGB

DATE: July 26, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14	8	0.20	0.06	17.2	28.65	
13	9	0.18	0.02			
12	8	0.34	0	17.5	28.75	
11	8	0.31	0			
10	8	0.61	0.22	17.4	28.68	
9	9	0.22	0.12			
8	8	0.48	0.17			
7	8	0.39	0	17.4	28.78	
$\bar{X}$		0.34	0.07	17.4	28.72	
σ		0.15	0.09	0.13	0.06	
%		43.4	116.4	0.7	0.2	

TRANSECT - SGB

DATE: August 9, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/oo	
14	9.5	0.43	0.24	20.4	28.24	
13	9	0.52	0.19			
12	9	0.43	0.17	21.0	28.42	
11	9	0.56	0.01			
10	9	0.61	0.09	21.0	28.61	
9	9	0.78	0.11			
8	9	0.61	0.14			
7	9	0.35	0.30	20.8	28.36	
$\bar{X}$		0.54	0.16	20.8	28.46	
σ		0.14	0.09	0.28	0.17	
%		25.2	57.7	1.4	0.6	

TRANSECT - SGB

DATE: August 15, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL *a* $\mu g.L^{-1}$	PHEOPIGMENTS $\mu g.L^{-1}$	TEMP. °C	SALINITY °/oo	
14	8	1.47	0.23	19.6	28.62	
13						
12	9	0.63	1.47	20.1	28.58	
11		0.95				
10		1.02		20.2	28.54	
9						
8						
7	11	0.86		20.2	28.58	
$\bar{X}$		0.99	0.85	20.0	28.58	
σ		0.31	0.88	0.29	0.03	
?		31.3	103.1	1.4	0.1	

TRANSECT - SGB

DATE: September 6, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL α $\mu g.L^{-1}$	PHEOPIGMENTS $\mu g.L^{-1}$	TEMP. °C	SALINITY °/oo
14				18.3	28.50
13					
12				19.2	28.20
11					
10				19.3	28.03
9					
8					
7				19.3	28.34
$\bar{X}$				19.0	28.27
σ				0.5	0.2
%				2.6	7.07

TRANSECT - SGB

DATE: September 13, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.L^{-1}$	PHEOPIGMENTS $\mu g.L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14						
13						
12						
11						
10						
9						
8						
7	7.5	1.02	0	17.2		

TRANSECT - SGB

DATE: September 19, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.L^{-1}$	PHEOPIGMENTS $\mu g.L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14						
13						
12						
11						
10						
9						
8						
7	5					

TRANSECT - SGB

DATE: September 28, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.L^{-1}$	PHEOPIGMENTS $\mu g.L^{-1}$	TEMP. °C	SALINITY °/oo	
14	8	1.36	0.57	14.50		
13	9	1.13	0.57	14.70		
12	8	1.47	0.37	14.75		
11	8	1.36	0.37	14.80		
10	8	1.93	0.56	14.90		
9	9	0.79	0.78	14.90		
8	9	0.79	0.58	14.90		
7	9	1.25	0.64	15.50		
$\bar{X}$		1.26	0.56	14.9		
σ		0.37	0.14	0.3		
%		29.4	24.7	2.0		

TRANSECT - SGB

DATE: October 18, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14	7	1.30	0.73			
13		1.73	0.21			
12	8	1.73	0.72			
11						
10		1.51	0.86			
9		1.51	0.35			
8		1.30	0.73			
7	9	3.89				
$\bar{X}$		1.85	0.60			
σ		0.92	0.26			
%		49.5	42.7			

TRANSECT - SGB

DATE: October 25, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL *a* $\mu g\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/₀₀
14	6.0	0.77	0.20	10.5	28.69
13	5.8	0.93	0.25	11.0	
12	5.5	1.09	0.46	11.05	28.57
11	5.8	1.15	0.38	10.85	
10	5.7	1.70	0.26	11.35	28.69
9	4.2	1.42	0.35	11.35	
8	3.8	1.31	0.46	11.30	
7	4.0	1.09	0.39	11.0	28.54
$\bar{X}$		1.18	0.34	11.05	28.62
σ		0.29	0.10	0.29	0.08
%		24.6	28.5	2.6	0.3

TRANSECT - SGB

DATE: October 31, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14	9	0.97	0.41	10.3	28.67	
13	7.5	1.07	0.50			
12	9	0.88	0.22	10.5	28.65	
11	8	1.17	0.17			
10	8	0.78	0.51	10.4	28.63	
9	7	0.97	0.41			
8	7	0.88	0.36			
7	8	1.20	0.19	10.4	28.69	
$\bar{X}$		0.990	0.35	10.4	28.66	
σ		0.149	0.14	0.1	0.03	
%		15.1	39.5	1.0	0.1	

TRANSECT - SGB

DATE: November 14, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/oo	
14	11	1.55		9.3	28.55	
13	11	2.04				
12	11	0.74	0.25	9.3	28.54	
11	12	1.27	0.07			
10	12	0.99	0.12	9.4	28.64	
9	12	1.02	0.08			
8	12	0.81	0.04			
7	12	0.88	0.02	9.2	28.68	
$\bar{X}$		1.16	0.10	9.3	28.60	
σ		0.44	0.08	0.1	0.07	
%		38.0	86.3	1.1	0.2	

TRANSECT - SGB

DATE: December 21, 1977

STATION NUMBER	SECCHI DEPTH M	CHLOROPHYLL a $\mu g.\ L^{-1}$	PHEOPIGMENTS $\mu g.\ L^{-1}$	TEMP. °C	SALINITY °/₀₀	
14						
13						
12						
11						
10						
9						
8						
7		1.45	0.54	1.3	27.94	

APPENDIX IV

Sedimentation at Stations 7 and 12

DATE May 16/77

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	3.24 (0.31)	3.32	0.46	20.5	124.6
18	5.54 (0.41)	3.63	0.52	168.0	253.2
21	17.65 (1.16)	2.78	0.41	35.8	452.7

When not otherwise indicated, all weights of deposited material were measured in open cylinders (31 cm high, 7.8 cm internal dia.). The letters O(open), S(small baffle tubes, 0.64 cm dis.), M(medium baffle tubes, 0.87 cm dia.), L(large baffle tubes, 1.91 cm dia.) and T(open cyclinder covered with 8 cm dia. top raised 1 cm above the cylinder mouth) refer to various trap collector designs exposed simultaneously at specified depths. Dry weight deposition was determined for single traps in these cases. In all other measurements, the mean (and standard deviation in parentheses) of sedimentation was determined for five open cylinders.

DATE May 24, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	0.98 (0.18)	5.06	0.74	64.6	66.9
18	1.47 (0.05)	3.67	0.49	11.5	30.1
21	5.23 (0.11)	5.51	0.82	7.2	70.3
Stn. 7					
25	1.58 (0.30)	4.49	0.76	155.1	139.1
32	3.00 (0.59)	4.67	0.92	378.6	133.0

DATE May 30, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	12.07 (0.20)	2.62	0.37	113.0	210.2
18	22.27 (1.01)	2.57	0.35	106.8	168.3
21	57.15 (1.91)	2.48	0.36	121.1	146.2
Stn. 7					
25	3.71 - M	3.45	0.38		
	5.43 (0.11)	3.45	0.42	290.9	93.9
30	7.73 (0.41)	3.70	0.45	139.9	175.2
32	27.45 (0.44)	1.73	0.22	253.4	207.2

DATE June 5, 1977

Depth m	Dry Weight $g.m.^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	1.33 (0.75)	4.58	0.51	172.4	91.5
18	2.80 (0.14)	2.98	0.32	260.1	172.6
21	4.12 (0.23)	3.43	0.44	165.9	224.1
Stn. 7					
25	1.81 - M 1.74 (0.06)	3.91	0.41	33.4	32.0
30	3.27 (0.28)	2.84	0.34	317.8	161.0
32	6.02 (0.99)	2.90	0.39	175.9	212.7

DATE June 13, 1977

Depth m	Dry Weight $g.m.^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	1.28 (0.17)	3.43	0.53	5.7	12.6
18	1.87 (0.43)	3.43	0.54	9.2	14.6
21	4.0 (0.52)	3.16	0.50	11.7	10.2
Stn. 7					
25	0.86 - M	5.96	0.54	5.2	2.6
	1.19 (0.21)	2.91	0.44	7.5	18.2
30	2.42 (0.20)	3.04	0.46	20.5	10.9
32	5.48 (0.16)	2.51	0.38	8.9	6.4

DATE June 21, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll *a* $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	0.61 (0.19)	3.75	0.73	103.0	60.3
18	1.06 (0.17)	4.51	0.57	202.8	134.5
21	2.17 (0.13)	5.31	0.51	209.4	138.9
Stn. 7					
20	0.38 - O 0.40 - S 0.30 - M 0.23 - L				
25	0.69 (0.38)	9.78	1.37	10.6	32.5
30	0.86 (0.33)	3.04	0.14	113.4	398.0
32	2.25 (1.01)	2.58	0.38	70.3	187.7

DATE July 4, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	1.00 (0.12)			20.5	31.6
18	1.94 (0.12)			70.9	177.3
21	2.95 (1.29)			86.7	151.1
Stn. 7					
20	1.29 1.61 - S 1.24 - M 0.74 - L				
25	2.57 (0.05)			89.5	12.7

DATE July 11, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll *a* $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	1.51 (0.46)			10.1	35.5
18	1.64 (0.51)			113.7	123.8
21	2.73 (0.16) 1.70 - T			42.5	186.8
Stn. 7					
20	2.60 - S 2.29 - M 1.18 - L				
25	5.26 (0.14)			60.8	70.2

DATE July 18, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	1.05 (0.06)	3.50	0.42	6.7	74.3
18	0.78 (0.25) 1.40 - T	1.80	0.14	11.4	144.2
21	0.77 (0.31)	2.28	0.27	118.3	
Stn. 7					
20	1.17 1.59 - S 1.77 - M 1.39 - L				
25	2.84 (0.11)	2.83	0.47	45.0	228.4

DATE July 26 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g \cdot g^{-1}$	Pheopigments $\mu g \cdot g^{-1}$
Stn. 12					
14	1.14 (0.34)	4.45	0.57	31.0	127.1
18	1.50 (0.21) 1.84 - T	3.81	0.48	7.7	63.4
21	4.39 (1.15)	2.78	0.37	18.3	64.1
Stn. 7					
20	2.18 2.19 - S 1.77 - M 1.30 - L				
25	1.11 (0.05)	3.60	0.38	10.2	77.7
30	1.55 (0.34)	3.48	0.48	11.6	113.8
32	4.49 (0.49)	2.15	0.25	19.7	59.4

DATE August 2, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	1.83 (0.15)	0.40	0.05	21.8	74.3
18	2.66 (0.21) 2.83 - T	0.64	0.08	21.8	59.4
21	5.31 (0.16)	0.47	0.06	24.0	87.1
Stn. 7					
20	1.52 1.73 - S 1.27 - M 1.03 - L				
25	1.86 (0.36)	0.45	0.05	12.8	63.2
30	3.43 (0.50)	0.60	0.08	100.4	332.2
32	10.19 (0.80)	0.54	0.07	20.0	81.8

DATE August 8, 197[illegible]

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	1.55 (0.07)	3.33	0.35	86.9	241.1
18	2.78 (0.05) 3.28 - T	1.96	0.27	84.8	172.7
21	8.69 (0.61)	1.64	0.24	50.8	107.2
Stn. 7					
20	1.30 1.25 - S 1.38 - M 1.14 - L				
25	1.60	3.65	0.51	23.0	182.0
30	2.78	2.76	0.38	39.4	265.6
32	7.16	2.43	0.33	62.5	90.6

DATE August 11, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	2.31 (0.10)	1.68	0.14	30.6	89.5
18	3.19 (0.31) 4.44 - T	3.33	0.36	64.8	138.4
21	6.20 (0.39)	2.50	0.27	54.1	142.1
Stn. 7					
20	1.77 3.29 - S 2.69 - M 2.47 - L				
25	2.02 (0.26)	1.93	0.09	65.5	291.8
30	3.72 (0.14)	3.24	0.34	41.5	161.9
32	11.06 (0.89)	1.55	0.18	19.6	115.2

DATE August 15, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Phecpigments $\mu g.g^{-1}$
Stn. 12					
14	1.96 (0.10)	6.67	0.84	67.0	314.0
18	3.72 (0.08) 2.74 - T	4.10	0.55	28.4	41.1
21	10.88 (0.54)	2.09	0.28	21.2	63.4
Stn. 7					
25	1.96 (0.07)	4.02	0.51	111.1	659.7
30	2.99 (0.68)	3.78	0.49	7.7	241.3
32	6.60 (0.97)	2.07	0.30	15.7	135.2

DATE September 6, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Phaeopigments $\mu g.g^{-1}$
Stn. 12					
14	1.35 (0.09)			88.9	312.0
18	3.09 (0.02) 3.50 - T			71.2	180.0
21	9.21 (0.14)			36.7	121.7
Stn. 7					
20	1.04 2.19 - S 1.58 - M 1.33 - L				
25	1.47 (0.39)			70.6	580.3
30	3.26 (0.06)			100.7	205.2
32	8.99 (0.20)			30.5	107.2

DATE September 13, 1977

Depth m	Dry Weight $g.m.^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	2.04 (0.16)	6.17	0.86	90.7	348.7
18	6.27 (0.07) 6.39 - T	3.10	0.43	87.7	195.9
21	17.66 (0.83)	2.37	0.33	55.7	228.2

DATE September 19, 1977

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	33.78 (0.84)	1.68	0.25	3.0	4.0
18	46.18 (0.95) 51.51 - T	1.62	0.24	2.2	3.8
21	161.06	1.26	0.19	2.1	4.2
Stn. 7					
20	6.51 2.10 - S 1.70 - L				
25	8.61 (0.74)	2.67	0.38	1.8	10.9
30	28.74 (2.37)	1.88	0.22	3.0	7.8
32	109.97 (1.79)	1.44	0.20	2.1	4.0

DATE Sept. 26/77

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll *a* $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	18.61 (1.08)	0.92	0.14	145.2	82.8
18	23.99 (0.98) 25.86 - T	1.08	0.16	77.8	97.4
21	43.63 (0.60)	1.53	0.22	57.5	83.2
Stn. 7					
20	2.42 2.34 - S 2.12 - M 2.26 - L				
25	3.11 (0.27)	0.98	0.11	179.3	143.6
30	3.86 (0.15)	2.89	0.42	166.7	312.4
32	6.64 (0.51)	1.50	0.21	190.8	202.9

DATE October 3, 1977

Depth m	Dry Weight $g.m^{-2}.day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	3.74 (0.06)	1.89	0.31	87.8	239.2
18	4.42 (0.69) 6.59 - T	2.09	0.36	55.6	199.9
21	10.47 (0.49)	1.66	0.27	64.2	99.4
Stn. 7					
20	1.31 1.70 - S 1.46 - M 1.13 - L				
21	1.72 (0.33)				
22	1.58 (0.44)				
23	1.32 (0.25)				
25	1.42 (0.27)	2.58	0.37	180.4	141.8
30	3.94 (0.34)		0.28	110.4	168.8
32	15.79 (0.20)	1.27	0.18	43.6	109.0

DATE: Oct. 18/77 STATION: 7

Depth	Dry wt. $g\ m^{-2}\ day^{-1}$	Mean	s.d.	%C	$\%\bar{C}$	%N	$\%\bar{N}$	Chlor.*a*	Mean Chlor.*a*	Phaeo.	Mean Phaeo.
20	0.92 O			3.79		0.53		241.9		482.8	
	0.78 S	0.79		3.46	3.13	0.37	0.38	416.1	318.0	633.4	597.3
	0.75 M			2.28		0.29		272.4		543.6	
	0.71 L			3.0		0.32		341.5		729.4	
21	0.68 M			4.49		0.35		277.8		588.8	
	0.49 O			2.75		0.16		159.8		297.4	
	0.58 O	0.56	0.06	3.08	2.48	0.32	0.21	283.2	212.4	517.4	453.1
	0.61 O			1.60		0.15		194.3		544.5	
22	0.98 M			3.21		0.31		325.9		595.4	
	0.62 M	0.80	0.25	2.41	2.81	0.17	0.24	129.5	227.7	247.4	421.4
	0.78 O			2.33		0.29		241.8		1014.8	
	0.56 O	0.67	0.16	1.22	1.78	0.14	0.22	175.6	208.7	370.7	692.8
23	0.53 M			3.42		0.31		302.1		704.5	
	M			4.13	3.78	0.41	0.36	223.3	262.7	652.1	678.3
	0.67 O			3.14		0.38		331.2		837.3	
	0.33 O	0.50	0.24	1.44	2.85	0.26	0.32	183.1	257.2	858.1	847.7
25	0.66			3.30		0.35		243.5		875.0	
	0.63	0.61	0.06	2.52	1.75	0.25	0.18	193.7	213.2	851.0	762.6
	0.55			0.79		0.06		143.1		502.1	
				0.37		0.05		272.3		821.9	
30	8.30			0.59		0.08		144.2		202.7	
	6.01	7.30	1.17	1.23	1.10	0.18	0.16	170.9	179.0	277.8	241.5
	7.60			1.72		0.25		191.2		145.6	
				0.85		0.12		219.7		339.8	
32	2.06			2.33		0.36		213.3		371.7	
	7.70	3.29	3.94	2.00	2.01	0.26	0.23	131.0	164.3	217.4	272.5
	0.11			2.26		0.23		154.1		298.9	
				1.44		0.08		158.8		202.0	

DATE: October 18, 1977 STATION: 12

Depth	Dry wt. $g\ m^{-2}\ day^{-1}$	Mean	s.d.	%C	$\bar{C}$	%N	$\bar{N}$	Chlor.*a*	Mean Chlor.*a*	Phaeo.	Mean Phaeo.
14	4.05			2.30		0.35		139.1		283.9	
	3.74	3.88	0.16	2.65	2.05	0.39	0.30	313.0	210.3	499.6	399.4
	3.85			1.15		0.17		187.9		375.0	
	---			2.11		0.27		200.9		439.0	
18	5.51			2.24		0.31		152.2			
	5.20	5.36	0.22		2.33	0.29	0.31	207.4	166.7	392.1	352.3
	6.07 - T			2.14		0.30		90.8		372.0	
				2.41		0.33		140.5		327.6	
21	9.66			0.89		0.10		147.4		170.8	
	9.30	9.72	0.46	2.19	1.75	0.28	0.23	459.6	210.8	----	115.4
	10.21			1.94		0.26		118.0		66.7	
				1.98		0.26		118.2		108.6	

DATE: Oct. 25/77 STATION: 7

Depth	Dry wt. $g\ m^{-2}\ day^{-1}$	Mean	s.d.	%C	%C̄	%N	%N̄	Chlor.a	Mean Chlor.a	Phaeo.	Mean Phaeo.
20	15.74 O			1.45		0.18		138.1		298.7	
	15.86 S			2.10		0.25		137.2		353.0	
	20.31 M	16.55		1.82	1.73	0.23	0.21	112.8	126.5	250.5	292.4
	14.58 I			1.53		0.17		117.9		267.4	
21	8.31 M			1.20		0.13		94.8		198.4	
	16.55 O			1.61		0.22		116.8		209.1	
	17.23 O	19.97		1.74	1.63	0.26	0.24	112.2	117.9	217.9	207.8
	14.12 O		1.53		0.23		124.8		196.4		
22	10.30 M		1.68		0.22		103.6		167.2		
	7.91 M	9.11	1.69	1.57	1.63	0.19	0.21	172.2	137.9	203.8	185.5
	15.62 O			1.65		0.19		106.8		154.9	
	14.85 O	15.24	0.54	1.54	1.60	0.22	0.21	129.6	118.2	188.0	171.5
23	8.40 M							127.6		205.9	

	17.83 O			1.71		0.27		126.4		192.9	
	16.74 O	17.29	0.77	1.59	1.65	0.25	0.26	109.8	118.1	199.8	196.4
25	17.31			1.74		0.24		103.5		200.9	
	16.30	16.72	0.53	1.70	1.75	0.23	0.23	126.5	112.8	188.7	187.2
	16.54			1.82		0.24		89.2		196.6	
						0.19		132.0		162.1	
30	21.07			1.79		0.20		97.7		125.8	
	20.00	20.54	0.54	1.78	1.77	0.24	0.21	69.9	95.9	185.3	159.1
	20.56			1.71		0.21		137.2		167.4	
				1.81		0.19		79.0		157.9	
32	45.26			1.43		0.21		52.4		135.9	
	40.13	42.4	2.62	1.09	1.26	0.13	0.17	54.0	52.1	98.1	113.8
	41.80			1.22		0.17		54.7		98.8	
				1.30		0.18		47.1		122.3	

DATE: Oct. 25/77 STATION: 12

Depth	Dry wt. $g\ m^{-2}\ day^{-1}$	Mean	s.d.	%C	$\%\bar{C}$	%N	$\%\bar{N}$	Chlor.*a*	Mean Chlor.*a*	Phaeo.	Mean Phaeo.
14	16.51			1.24		0.17		82.9		140.7	
	19.29	18.39	1.63	1.13	1.36	0.15	0.18	96.6	87.9	155.9	155.9
	19.38			1.60		0.22		79.3		177.2	
	---			1.46		0.18		92.7		149.7	
18	24.46			1.79		0.23		62.7		152.5	
	23.92	24.19	0.38	1.61	1.58	0.20	0.20	62.4	61.8	155.6	152.0
	24.19 T			1.51		0.18		71.2		180.0	
				1.40		0.17		60.2		148.2	
21	37.56							46.1		139.8	
	39.30	39.01	1.33	1.07	1.10	0.14	0.14	0.14	48.7	129.5	134.4
	40.18			1.08		0.12		34.6		134.8	
				1.16		0.16		40.3		133.5	

DATE Oct. 31/77

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	17.71 (0.78)	1.70	0.24	177.4	177.6
18	18.61 (0.31) 17.03	1.84	0.25	122.3	167.5
21	18.59 (1.01)	1.49	0.20	115.5	152.1
Stn. 7					
20	16.54 9.88 - S 5.59 - M 9.70 - I				
25	14.35 (1.31)	1.55	0.19	88.8	128.9
30	17.95 (0.50)	1.78	0.23	126.7	169.3
32	43.70 (1.29)	1.44	0.16	67.0	94.9

DATE Nov. 15/77

Depth m	Dry Weight $g.m^{-2}day^{-1}$ (s.d.)	Percent Carbon	Percent Nitrogen	Chlorophyll *a* $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$
Stn. 12					
14	12.54 (0.43)	1.75	0.25	108.7	189.6
18	16.57 17.97 - T	1.85	0.26	96.6	199.3
21	22.76 (0.78)	1.84	0.26	70.7	120.0
Stn. 7					
20	12.76 7.41 - M 14.42 - L				
25	13.66 (0.19)	1.73	0.24	86.8	125.9
30	16.50 (0.66)	1.82	0.27	55.8	135.7
32	28.96 (0.74)	1.65	0.25	50.3	82.9

APPENDIX V

Sedimentary Organic Matter at Stations 7 and 12

ORGANIC AND PIGMENT CONTENT IN BOTTOM SEDIMENTS ST. GEORGES BAY, 1977

DATE	Station No.	Percent Carbon	Percent Nitrogen	C:N	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$	Chlorophyll a as % total pigment	C:Chlorophyll a
Aug. 8	12	0.37	0.05	7.4	26.6	72.6	26.8	139.1
	7	0.96	0.13	7.4	10.3	51.5	16.7	932.0
Aug. 11	12	1.64	0.19	8.6	43.4	50.1	46.4	377.9
	7	0.82	0.08	10.3	3.5	16.4	17.6	2342.9
Aug. 15	12	0.70	0.10	7.0	25.0	47.1	34.7	280.0
	7	4.80	0.18	26.7	36.8	83.5	30.5	1304.3
Sept. 6	12				17.7	37.9	31.8	
7	7				10.7	39.8	21.2	
Sept. 13	12	1.63	0.17	9.6	12.2	47.5	21.1	1336.1
Sept. 19	12	0.94	0.13	7.2	1.2	2.6	31.6	7833.3
	7	1.14	0.16	7.1	1.3	2.7	32.5	8769.2
Sept. 26	12	0.24	0.03	8.0	4.4	10.2	30.1	545.5
	7	1.07	0.15	7.1	13.7	25.8	34.7	781.0

ORGANIC AND PIGMENT CONTENT IN BOTTOM SEDIMENTS ST. GEORGES BAY, 1977

DATE	Station No.	Percent Carbon	Percent Nitrogen	C:N	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$	Chlorophyll a as % total pigment	C:Chlorophyll a
June 13	12	0.68	0.10	6.8	1.8	3.5	34.0	3777.8
	7	1.17	0.17	6.9	6.3	3.4	64.9	1857.1
June 22	12	1.67	0.23	7.3				
	7	1.49	0.17	7.2	53.1	217.8	19.6	280.6
July 4	12				34.7	162.6	17.6	
	7				55.4	18.9	74.6	
July 11	12				22.7	17.3	56.8	
	7				5.1	23.5	17.8	
July 18	12	0.92	0.10	9.2	20.5	44.8	31.4	448.8
	7	1.14	0.13	8.8	16.9	66.7	20.2	674.6
July 26	12	1.43	0.14	10.2	4.5	10.8	29.4	3177.8
	7	0.65	0.08	8.1	2.3	19.9	10.4	2826.1
Aug. 2	12	0.20	0.02	10.0	7.0	32.6	17.7	285.7
	7	0.18	0.02	9.0	10.3	51.4	16.7	174.8

ORGANIC AND PIGMENT CONTENT IN BOTTOM SEDIMENTS ST. GEORGES BAY, 1977

DATE	Station No.	Percent Carbon	Percent Nitrogen	C:N	Chlorophyll a $\mu g.g^{-1}$	Pheopigments $\mu g.g^{-1}$	Chlorophyll a as % total pigment	C:Chlorophyll a
Oct. 3	12	0.26	0.04	6.5	6.3	11.0	36.4	412.7
	7	0.67	0.09	7.4	24.3	22.3	52.1	275.7
Oct. 18	12	1.28	0.13	9.8	44.4	36.3	55.0	288.3
	7	0.95	0.08	11.9	14.6	21.1	40.9	650.7
Oct. 25	12	1.22	0.13	9.4				
	7	1.20	0.13	9.2	28.6	9.5	75.1	419.6
Oct. 31	12	1.29	0.15	8.6	14.1	41.1	23.4	914.9
	7	1.25	0.14	8.9	13.2	33.4	28.3	946.9
Nov. 15	12	0.43	0.05	8.6	3.5	9.4	27.1	1228.6
	7	1.32	0.19	6.9	16.7	35.2	32.2	790.4